Crop Diversification Centre South

Annual Report 2003

Crop Diversification Centre South
Brooks Alberta

Alberta
AGRICULTURE, FOOD AND
RURAL DEVELOPMENT

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Introduction

C.L. Murray, Branch Head

The Crop Diversification Centre South (CDCS) is one of the research and development units of the Crop Diversification Division of Alberta Agriculture, Food and Rural Development (AAFRD). The CDCS focus is on applied research and technology transfer in support of the horticulture, special crop, forage seed and agronomy in Alberta. The Centres' mandate of crop diversification and industry development is achieved through close partnerships with commodity organizations, grower groups, agribusinesses, university, federal and private sector researchers, agricultural colleges, and individual producers and processors.

This annual report covers the activities of CDCS staff at Brooks, Lethbridge, and Oyen. Only brief summaries of projects and trials carried out in 2003 are reported here. Please refer to the *Publications and Presentations* section of this report for sources of more detailed information.

2003 has been a very successful for the Crop Diversification Centre South. Program Leaders attracted almost $1 million in matching and external research funds. This level of funding commitment from our partners is a testament to the quality of research CDCS scientists are conducting as well as their commitment to the industry. Our partners include funding agencies (Alberta Crop Industry Development Fund, AVAC, and the New Initiatives Fund), industry organizations and agri-businesses.

The Industry Development Sector of which the Crop Diversification Centre South is a part of has been leading the Alberta's Agri-Food Industry Growth Strategy. The goal of the Growth Strategy is to grow the primary products industry to $10 billion and the value-added industry to $ 20 billion by 2010. Five Key Initiatives have been defined where there is a very great potential for growth, they are: Functional Foods and Natural Health Products, Beef, Pork, Processed Meats and Ready Meals and Bio-industrial Products. A significant number of Base Hits have been defined as important opportunities with smaller growth potential. CDCS Staff have projects aligned with both Key Initiatives and Base Hits and are working hard through their research skills to help Alberta's Agriculture Sector meet the growth goals.

There have been a number of staff changes in 2003:

- Scott Meers has rejoined CDCS after a two year education leave at the University of Montana, Bozeman, where he was studying the stem wheat sawfly.
- Trevor Wallace, Integrated Crop Management Specialist in Oyen has taken a two year secondment to the Technical Services Division as Project Leader Nutrient Management Strategy.
- Robert Dunn, Integrated Crop Management Specialist in Lethbridge, has taken a Conservation Cropping Specialist position with the Conservation and Development Branch, Resource Management and Irrigation Division.
- Elizabeth Russel, Special Crop Technologist, Andrew Fox, Special Crops Technologist and Kevin Seward, Agronomy Technologist, have moved on to new opportunities.

Agronomy Program

R. McKenzie and A. Middleton

The focus of the agronomy research program is to increase production and quality of new and conventional dryland and irrigated crops in Alberta. The program focuses on development of information for producers on nutrient management and agronomic recommendations. Research involves analyzing soil fertility and crop nutrition needs, agronomic needs, developing and designing research protocol, implementing and co-ordinating research projects, analysing research results, formulation of crop production models and developing soil fertility, crop nutrient and agronomic recommendations for crops in the various agroecological regions of the Alberta.

Research activities are interdisciplinary to examine broader scope interactive agronomic issues of soil fertility and fertilizers with weed populations, herbicide performance, plant disease levels, insect population levels and cropping systems. Field and laboratory experiments are conducted. The research programs involve private industry, federal and provincial researchers. The end results are development of soil fertility, crop nutrition and agronomic information for making recommendations for a wide range of conventional and alternate crops in all major agroecological areas in Alberta.

Research Projects

Development of agronomic practices for chickpea production

A four year research project was conducted with funding from Agricore United and the Alberta Pulse Grows Commission. The project used two chickpea types Desi and Kabuli with fertilizer trials including: N fertilizer with and without inoculant, 4 rates of phosphate, 3 rates of potash and 3 rates of sulfate. The agronomy trials included 3 seeding dates each with 5 seeding rates. A total of 20 site years of data has been collected. A final report and recommendations will be completed in 2004.

Development of agronomic practices for mustard production

A four year research project was conducted with funding from Agricore United, Mustard Growers Association, Westco and Agrium. The project used three mustard types: Yellow, Brown, Oriental, and one canola variety for comparison. Fertilizer trials included: 5 nitrogen rates with each mustard type, 4 rates of phosphate, 3 rates of potash and 3 rates of sulfate. The agronomy trials included 3 seeding dates each with 5 seeding rates. A total of 20 site years of data has been collected. A final report and recommendations are nearing completion.

Malting barley agronomic management

A three year research project was conducted with funding from Agrium and Cargill. The project used seven malting barley types: Harrington, 2-row: Metcalfe, Kendall, Stratus; 6-row: Excel, B1602, and Sisler. Fertilizer trials included: 5 nitrogen rates with each variety, 4 rates of phosphate, 3 rates of potash and 3 rates of sulfate. The agronomy trials included 3 seeding dates each with 5 seeding rates for Metcalfe and Excel. A total of 12 site years of data has been collected. A final report and recommendations will be completed in 2004.

Triticale agronomic management

A one year trial was conducted without funding to explore the potential of triticale under irrigation. The project used 2 varieties: Pronghorn and Ultima with fertilizer trials including: Fertilizer trials included: 5 nitrogen rates with variety. The agronomy trials included 3 seeding dates each with 5 seeding rates for Pronghorn. Data will be reviewed and assessed for development of a new larger project in 2005.

Coated N urea management for winter wheat

This was the third of a four year project conducted with Agrium to assist in development of new urea coated nitrogen fertilizer. The final two years also has funding from RT Linkages and Ducks Unlimited. This project uses AC Tempest winter wheat and seed-places and side banding four rates of urea (46-0-0), Type I (20 day slow release) and Type II (40 day slow release) coated urea. At the end of the project in 2004, there will be 8 site years of data. The project is assessing the effectiveness of the various products. To date the coated urea, manufactured in Alberta, is working well and is already being marketed in the USA.

Agronomic management of winter wheat and winter triticale

This was the first of a two year trial conducted with RT Linkages and Ducks Unlimited. This project uses AC Tempest winter wheat and Bobcat winter triticale. Each crop has two seeding dates with 5 seeding rates, each seeded using both a hoe and disk opener. At the end of the project in 2004, there will be 6 site years of data. The project is assessing the effectiveness of seeding date, seeding rate and low versus high disturbance seeders.

Long-term dryland crop rotation study in the brown soil zone

This was the twelfth year of a long-term crop rotation study conducted in the Brown soil zone at the Bow Island substation. The rotations included: continuous wheat, wheat-fallow, wheat-wheat-fallow, wheat-pea, wheat-flax-fallow and grass rotations. Several papers have been published on the long-term effects on soil quality and on the economic benefits of each rotation. Without funding the project may be terminated in 2004.

Long-term soil phosphorus and phosphate fertilizer study

This was the tenth year of a long-term phosphorus fertilizer study conducted in the Brown soil zone at the Bow Island substation. A second site was terminated at Pincher Creek in 2002. The rotations included continuous wheat and wheat-fallow. Each had a number of different phosphorus management treatments. Without funding the project was terminated in 2003. A final report will be written in 2004 after data analysis.

Development of P-S fertilizer products

A confidential research project was conducted for Shell Canada Ltd on new fertilizer product development. A final report will be completed in 2004.

New Research Projects for 2004

Irrigated Timothy Production:

A new four year research project has been initiated with the Irrigation Branch to conduct irrigation and nutrient management trials with irrigated timothy. Funding will come from ACIDF, Agrium, Westco, Cargill and several timothy hay processors. The nutrient management trials will be at Lethbridge and Bow Island. Approximately 30 fertilizer trials included rates and forms of nitrogen fertilizer, phosphate and potash. There will be three irrigation research sites at Picture Butte, Bow Island and Rolling Hills. There will be four irrigation management levels. The project will start in 2004 and should be completed in 2008.

Irrigated Soft White Spring Wheat Production

A three year research project will be initiated in 2004 with funding from ACIDF, Agrium and Westco. The project will use four new soft white spring wheat varieties. Fertilizer trials included: 5 nitrogen rates with each variety, 4 rates of phosphate, 3 rates of potash and 3 rates of sulfate. The agronomy trials included 3 seeding dates each with 5 seeding rates for two varieties. A total of 9 site years of data will been collected. The project will start in 2004 and should be completed in 2007.

Technology Transfer

New Extension Project for 2004

Diagnostic field school

CDCS will partner with the Southern Applied Research Association and AAFC - Lethbridge to deliver a Soil and Crop Diagnostic Field School at the Lethbridge Research Center in 2004. The field school will focus on three opportunity crops for dryland production in southern Alberta including: winter wheat, mustard and peas.

Agronomic research results and recommendations are disseminated to government and industry extension staff, Alberta producers and other researchers. Dissemination of information is through conferences such as the Agronomy Update, press releases, seminars and meetings, fact sheets, technical reports, the Internet, field days and the soil and crop diagnostic field school. Scientific papers and technical project reports are prepared for publication at scientific meetings, workshops and seminars. In-service training is provided to AAFRD staff and industry. Advice and direction is given on prairie wide research needs and problems, development and execution of interdisciplinary research, and provide consultation to other scientific researchers and extension agronomists

Fruit and Vegetable Research Program

C. Neeser, T. Pheh and M. Webber

The goal of the fruit and vegetable research at program at CDCS is to support the expansion of a value added fruit and vegetable industry in Alberta, by providing growers and processors with production knowledge that will lead to a competitive advantage through innovation.

Research covers topics as diverse as pest management, cultivar selection and post-harvest storage. Most projects involve field research, which are conducted at CDCS, or on field sites provided by collaborators. In most cases work is done in partnership with researchers from universities or other government institutions. The research priorities are driven by the Industry Development Sector's mission to grow the agricultural industry in Alberta.

Research Projects

Vegetable Research

Juice yield and quality of selected carrot cultivars

Demand for carrot juice is growing in the beverage industry which presents an opportunity in vegetable production. Cultivar selection is an important consideration in the production of carrot juice, due to varying quality characteristics and juice yield. Suitable juicing cultivars adapted to Alberta need to be identified. The objective of this study was to compare total yields and juice yields of 15 carrot cultivars suitable for commercial production.

The highest yielding cultivars were Royal Cross, Tempo, and Bolero, with respectively 16.0 t/ha, 14.1 t/ha and 12.3 t/ha. These also produced the highest juice yields, ranging from 53.1% for Royal Cross to 50.5% for Bolero. Further trials are required to confirm the superior performance of these cultivars. Quality parameters, such as sugar content, sugar composition, carotene content and pH are currently being measured and will be reported at a later date.

This trial was conducted in collaboration with Dr. Darcy Driedger, Food Science and Technology, CDCS. The carrot cultivars were supplied by Daehnfeldt Inc., Evergro Canada, Harris Moran Co., Sakata Inc., Siegers Seeds Co., Sunseeds, and Vilmorin Clause & Co.

The influence of nitrogen and compost on carrot yield and quality

Fertilizer is a significant production cost that may cut into profit margins, if applied at higher than necessary levels. Excessive fertilizer can also have other detrimental effects, including water pollution, increased weed competition, increased susceptibility to diseases, and root malformation. Compost can reduce some of the problems associated with intense fertilizer use. Compost from feedlot manure is readily available in Alberta and could be used in carrot production. Research data are needed to support this use on irrigated soils. An experiment was set up to quantify carrot yield response to increasing levels of ammonium nitrate with and without composted feedlot manure. Composted manure was provided by Agricore-United.

The results showed that nitrogen applied in the form of ammonium nitrate produced only a slight increase in yield, when applied at the rate of 50 kg/ha. No benefit was observed at the 100 kg/ha rate. With compost manure, yield increased only when applied at the rate of 50 t/ha. Composted manure had the additional beneficial effect of reducing the incidence of forked carrots. The lack of a more pronounced yield response to nitrogen was probably due to relatively high levels of nitrogen in the deeper soil profiles. Additional studies will be conducted to develop better guidelines for fertilizer requirements in carrots.

Use of calcium chloride foliar sprays on field grown vegetable crops

The objective of this study was twofold:

- To determine whether foliar applications of calcium chloride will result in higher levels of calcium in the edible portion of romaine lettuce, carrots, and broccoli,
- To measure whether calcium treatments would decrease moisture loss in storage.

Treatments consisted of 0 to 6 foliar application of a 1% calcium chloride solution. Calcium chloride is one of the forms of calcium that is easily absorbed by plants when used as a foliar spray. However, in this experiment, only lettuce treated six times showed on average increased calcium content. Single applications actually slightly reduced the amount of calcium, which suggests that the treatment interfered with normal calcium uptake and/or translocation. Given that the treatments didn't produce a substantial change in the amount of calcium present in the plant tissue, it is not surprising that weight loss during storage was similar for all treatments. The most likely cause of the poor absorption appears to be the non-ionic surfactant (Agral90®), which was added to the spray solution to enhance penetration through the leaf cuticle. Additional work is underway to clarify this matter. This project is being conducted in collaboration with Dr. Nick Savidov, Greenhouse Crops Program.

Comparison of drip and sprinkler irrigation in vegetable production

Water is often a limiting factor for vegetable production in Alberta. Drip irrigation systems are well established in other vegetable production areas, but are not yet widely adopted here. The purpose of this study is to compare the performance of a sprinkler and a drip irrigation system for vegetable production.

In this experiment drip irrigation presented no advantage over solid set sprinklers in terms of yield and water use efficiency. In fact, lettuce performed better under the sprinkler system. These results are not consistent with what is generally reported in literature. The poor performance of the drip irrigation system could have been caused by technical problems. There were difficulties with pressure regulators, which may have reduced uniformity or water distribution along the drip line.

This study was made possible through the financial contribution of the Alberta Professional Horticultural Grower Congress & Foundation Society and the Alberta Farm Fresh Producers Association.

Timing of onion transplants

Onions in the Canada #1 Jumbo category, (>3 in. diameter), often referred to as slicing onions, are in high demand. In order to achieve the required size under southern Alberta conditions, onions have to be grown from transplants. This study was to evaluate the effects of seeding and transplanting dates on onion yield and size.

Yield data showed that early February was the best time for seeding and late April or early May was the best time for transplanting. However, 2003 was a very unusual season, due to a very late spring. In most years mid-April is probably the best time for transplanting. This experiment will be repeated in 2004 to obtain a measure variability between years.

Comparison of selected biofertilizers and soil inoculants

An ever-increasing number of "biological" fertilizers are being marketed to growers. Independent testing is needed to help growers make better purchasing decisions. A trial was set up with romaine lettuce to evaluate some products currently on the market. There were two natural sources of nitrogen (alfalfa meal and seabird guano) and two types of soil inoculants (Jump Start™ and N-Fix Soil Bio®). The controls were ammonium nitrate at 100 kg/ha and no fertilizer.

All treatments produced lower average yields than without the fertilizer control. The lowest yield averages for fertilizers occurred with alfalfa meal and seabird guano. For soil inoculants the lowest average was observed with Jump Start™. None of the effects was statistically significant. The lack of treatment response was most likely due to fertilizer accumulation in the lower soil profile. In this case the abundance of nutrients, in particular nitrogen, would have cancelled any beneficial effects from the fertilizer and inoculants supplied. Unfortunately, at the time of selecting a site soil analyses for depths in excess of 60 cm were not available. Repetition of this trial on a more representative site is in order.

This project was conducted in collaboration with Dr. Ron Howard, Plant Pathology Program. Financial support was provided by Alberta Farm Fresh Producers Association. Biofertilizers and inoculants were donated by Gaia Green Products Ltd (alfalfa meal, seabird guano), Philom Bios Ltd. (Jump Start™), and Bio Ag Ltd (N-Fix Soil Bio®).

The influence of Accent® on the performance of three sweet corn cultivars

Alberta Vegetable Growers (Processing) indicated that it is in the interest of their membership to obtain a User Requested Minor Use Label Extension to allow the use of Accent® on sweet corn. Accent® (nicosulfuron) would provide post-emergence control of wild oats (*Avena fatua*), green foxtail (*Setaria viridis*), and quackgrass (*Elytrigia repens*). The Pest Management Regulatory Agency requested additional data on crop tolerance for this label extension.

A field trial was conducted for the second year in a row, to determine whether Accent® applied at the 1-6 leaf stage will cause visible injury symptoms and yield loss on Krispy King, Jubilee Super Sweet, and Jubilee cultivars. Treatments consisted of Accent® applied at the label rate, twice the label rate, and an untreated control.

Although small yield reductions were observed in some cases, none were statistically significant. Accent® should therefore be deemed safe for use on these varieties. These results were consistent with studies of the same nature conducted in parallel at -Bow Island substation and at the AAFC - Scott, SK. The data will be submitted to the Pest Management Regulatory Agency to support a request for a minor use label extension.

This work was made possible with the financial assistance of the Alberta Vegetable Growers (Processing) and the support of Dupont Canada. Seed was provided by Lucerne Foods Ltd. (Lethbridge).

Fruit crops

Integrated crop management of black currants in Alberta

This is a collaborative project that inbolves Prairie Natural Processing Inc., ARC and CDCS. The role of the fruit and vegetable program is to conduct field experiments at ten black currant orchards to address the following objectives:

- to quantify the performance and development of currently recommended black currant cultivars,
- to compare the effect of mulches on growth performance in different orchards,
- to quantify the response to nitrogen fertilizer, and
- to assess yield benefits of drip irrigation.

In 2003, the second year of this project, the highest yielding cultivars were Ben Lomond and Ben Nevis, with 1.8 kg/bush and 2.3 kg/bush respectively. This was consistent with last year's results. Drip irrigation applied to the Ben Nevis bushes resulted in a 7 % yield increase compared to no irrigation. The nitrogen fertilizer treatments had no beneficial effect on yield, indicating that existing levels present in the soil were sufficient (50 to 100 kg/ha). The highest yields were achieved with black plastic mulch but the response varied between cultivars, with some responding less than others. This project will continue in 2004.

Funding was provided by the Alberta Agricultural Research Funding Consortium, Alberta Farm Fresh Producer Association, Alberta Professional Horticultural Growers Congress and Foundation Society, Fruit Growers Society of Alberta and Prairie Natural Processing Ltd.

Black currant cultivars

Numerous black currant cultivars have been developed in Europe. However, growing conditions there are quite different from Alberta. In the May of 2003 a trial was established with nine Russian cultivars not previously tested under Alberta conditions. The first assessments of these cultivars will be made in 2004, to evaluate winter survival and disease resistance. The cultivars were provided by McGinnis Berry Crops Ltd.

Dwarf sour cherry

The Domestic Fruit Breeding Program at the University of Saskatchewan (U of S) has released a dwarf sour-cherry cultivar suitable for the Prairies. Several advanced selections will most likely be released in the near future. The objective of this project is to evaluate winter hardiness and yield performance of some of the advanced dwarf sour cherry selections. In August of 2003 six cultivars were planted in a replicated trial. Winter survival, disease incidence, and growth will be assessed during the 2004 growing season.

Dwarfing apple rootstock

Modern apple production requires the use of disease resistant dwarfing rootstock that is climatically adapted. Currently the recommended rootstock for the Canadian Prairies is Ottawa #3. However, in many cases this rootstock has proven insufficiently winter hardy. It also appears that it is not the optimal rootstock for the new apple cultivars that are currently being developed at the U of S.

To address this problem two screening trials were established; one with the Dr. John Cline, University of Guelph, the other with Dr. Robert Bors, U of S.

Apple cultivars

The U of S has supported a breeding program for Prairie-hardy apples since the early 1940's. In recent years several selections with excellent commercial potential have been identified. In 2003 the fruit and vegetable program began to collaborate with the Domestic Fruit Breeding Program at the U of S to test seven promising selections in plant hardiness zone 3a, with strong chinook influence. The trees were grafted onto V3 rootstock last May and planted in July. In the spring of 2004 these trees will be assessed for winter damage and growth will be measured at the end of the season. Initial fruit production is expected by 2007.

Orchard ground covers

The choice of ground cover is an important orchard management decision. Ground covers reduce erosion, soil compaction, facilitate harvest, keep weeds in check, and provide shelter for beneficial insects. However, there are also some drawbacks, which include the need for mowing, competition for nutrients, and habitat for insect pests. A desirable ground cover should minimize these undesirable characteristics.

The purpose of this experiment is to evaluate six native grasses for their suitability as orchard ground covers. These grasses are adapted to drought conditions and are expected to provide good cover with minimal maintenance.

This project is being conducted in collaboration with Dr. Jay Woosaree from ARC - Vegreville native plant program.

Strawberry

In Alberta strawberries are a very important crop to a large number of U-pick operations. The fruit and vegetable program continues to support this industry by screening newly released cultivars and breeding lines for their usefulness in Alberta. In 2003 yield data was obtained from 29 cultivars planted in 2001 and from 9 cultivars planted in 2002. In the 2001 planting, yields ranged from 0.15 kg per 2 metre row to 4.72 kg per 2 metre row. The seven highest yielding cultivars in decreasing order were LL979-46, SJ942-3, Glooscape, Brunswick, Chambly, Kent, and SJ9330-10. These cultivars were all above 3 kg per 2 metre row. In the 2002 planting, yields ranged from 0.1 to 2.59 kg per 2 metre row. The highest yielding ones in decreasing order were Kent, APF 9323-3, St-Pierre, and LL9324-24. The yields of these four were above 1.8 kg per 2 metre row.

The collaboration of Dr. Sharokh Kanizadeh, strawberry breeder at the AAFC - St-Jean sur Richelieu, is gratefully acknowledged.

Technology Transfer

Extension activities included a field day for the Fruit Growers Society of Alberta at CDCS and at CDCN, a field day at Richard's black currant orchard near Red Deer (Prairie Natural Processing Inc.), several presentations at the Fruit and Vegetable Highlights seminar in Lethbridge, Stettler, and Red Deer, and a presentation at the Alberta Vegetable Growers (Processing) annual meeting. Contributions were also made to newsletters of the Alberta Farm Fresh Producers Association, the Fruit Growers Society of Alberta and the Alberta Vegetable Growers (Processing).

Grass Seed and Forage Crops Program

H. Najda and A. Kruger

The grass seed and forage crops program conducts agronomic and adaptability research to develop and provide information on grass seed production and on traditional and new forage crops.

Several trials were conducted in cooperation with other research institutions and agencies. These included, the CDCN (grass seed production, bio-fuel) and the ARC - Vegreville (grass seed production).

The following companies and institutions sponsored various research projects in 2003: Agricore United (AB); AAFC; ARC - Vegreville (AB); Brett-Young Seeds (MB);

Cal/West Seeds (Wisconsin, USA); Deutsche Saatveredelung (Germany); DLF-Trifolium (Denmark); Dyck Seeds (MB); Lamorna Enterprises Ltd (AB); Moore Seed Processors (AB); Newfield Seeds (SK); Northstar Seed Ltd. (MB); Parsons Seeds (ON); Pickseed Canada (ON); Pioneer Hi-Bred Ltd. (ON); Prairie Seeds Ltd. (AB); Richardson Seeds (BC); The Scotts Co. (Oregon, USA); Tomorrow's Seed (BC) and Turf-Seed Inc. (Oregon, USA).

Research Projects

Perennial Grass Seed Production Studies

Perennial grass seed production has become a major area of research in southern Alberta. Many seed companies from Canada, the United States and Europe are now contracting production acres in southern Alberta under irrigation and rainfed areas throughout the province.

A cooperative province-wide project, headed by Dan Cole, Weed Specialist, CDCN, to determine the effects of fall-applied herbicides on different grass species for seed production was completed in 2003. Information from this project is being used to obtain Minor Use Registration for several herbicides in 2004 for tall, creeping red, chewings and hard fescue, perennial ryegrass, Kentucky bluegrass and timothy.

A new trial was initiated to investigate the effect of manganese sulfate on grass seed yields on high pH soils. First year results did not show statistical significance among treatments but there was a trend for higher yields using manganese sulfate.

In 1998 the Western Grass Seed Testing Program (WGST) was started to provide seed yield and adaptability information to the seed industry. The trials are a cooperative effort of federal and western provincial research and extension staff and the seed industry. Testing sites are located at Fort St. John in BC; Beaverlodge, Bow Island, Brooks and Vegreville in AB; Melfort and Saskatoon in SK and Arborg and Portage La Prairie in MB.

Species currently being tested include Kentucky bluegrass, smooth bromegrass, chewings and creeping red fescue, hard, meadow and tall fescue, orchardgrass, perennial ryegrass, timothy and some native species. Results of this program have contributed to increased contract seed production not only in southern Alberta but the rest of the province and Western Canada especially of newer grass species such as tall fescue, perennial ryegrass, Kentucky bluegrass and meadow bromegrass.

The grass seed and forage crops program at CDCS is responsible for seed acquisition and distribution to test cooperators and the production of an annual report for both seed producers and the seed trade. This report is available on Ropin' the Web at <http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/for7820/$file/wgst_2003_report.pdf?OpenElement>

Western Forage Testing Program

The Western Forage Testing Program (WFT) began in 1995. This is a cooperative tri-province (AB, SK and MB) venture which tests forage cultivars for registration purposes. In most cases, enough location years are incorporated into the testing program to provide a basis for registration and to provide data for particular agro-climatic areas. In 2003, the Alberta Forage Variety Committee (AFVC) supported one cultivar each of alfalfa, orchardgrass and timothy for registration.

The grass seed and forage crops program at CDCS is responsible for seed acquisition and distribution to test cooperators and the production of an annual report for both seed producers and the seed trade. The annual report for 2003 is available on Ropin' the Web at: <http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/for7817/$file/wft_2003_report.pdf?OpenElement>

Information from this program is used to annually update the Agrifax pamphlet *Varieties of Perennial Hay and Pasture Crops for Alberta*. Agdex 120/32. This information is also available on Ropin' the Web at: <http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/agdex105?opendocument>

Forage Agronomy

The grass seed and forage program is participating in a New Initiatives Fund project that was seeded in 2003. As a test location, dryland trials were established at Brooks and include such grasses as switchgrass, tall fescue and Dahurian wildrye. Some of the objectives of this project are:

- to identify crops that have the potential as dedicated energy or dual crops for biomass production in Alberta
- to establish marker compounds for lignocellulosic content in biomass
- to evaluate the effects of environment on energy content and quality of biomass.

Technology Transfer

The program leader, H. Najda, provides information services to growers, industry personnel, producer and commodity organizations and other AAFRD staff. In 2003, presentations were made at several industry and producer meetings and provincial advisory committees. A presentation was made at an international herbage seed conference held in Australia. Two information pamphlets on forage variety performance and information on the Ropin' the Web site were updated. The program leader co-authored one scientific publication and wrote several magazine articles.

The program leader participated on the Alberta Forage Variety Committee, the Alberta Alfalfa Seed Committee, the Western Grass Seed Testing Committee, the Western Forage Testing Committee, and the board of directors of the Chinook Applied Research Association.

Greenhouse Crops Program

N. Savidov, P. Coté, J.A. Hughes, D. Terry, B. Kozak, N. Mohammed, T. Schroeder, and S. Chambo

The last year proved to be very successful for the program. The results of the "Edible Coating for Greenhouse Vegetable" project paved the road for commercialization of this technology for peppers. A collaborative project on aquaponics has lead to the building of the first research aquaponic facility in Western Canada.

The program received another two grants one from the New Initiatives Fund for "Evaluation and Development of Aquaponics Production and Product Market Capabilities in Alberta" and a second from the Alberta Crop Industry Development Fund for "Evaluation of greenhouse substrates containing Zeolite and secondary use of spent substrate".

This success would be impossible without a strong industry support including Red Hat Cooperative; Industrial Mineral Processors; Millenniumsoil Coir; BioWorks Inc.; Alberta Fish Farmers Association; Alberta Greenhouse Growers Association; Air Liquide Canada Inc.; Industrial Mineral Processors; Westgro Horticultural Supplies Inc.; Argus Control Systems Ltd.; BioWorks Inc.; Biosphere Technologies; Alberta Fish Farmers Association; Noviant, Seair; VG International; Atofina; Pearlchem; Strahl & Pitsch; Circle M Trout Farm and Klok Feeds.

The program continued consultations with academic, educational, provincial and federal institutions including University of Alberta, University of Saskatchewan, University of Lethbridge, Olds College, Lethbridge Community

College, ARC, AAFC, NRCC Plant Biotechnology Institute and internationally with UN Development Program-Dryland Development Center, Costa Rica, University of Virgin Islands, USA, USDA-ARS Children's Nutrition Research Centre Plant Growth Facility in Baylor College of Medicine, Houston, Texas, USA, Ben-Gurion University, Israel, University of Freiburg, Germany, Stellenbosch University, South Africa and Moscow Agricultural University, Russia.

Research trial reports are presented in *Greenhouse Business*, a AAFRD, bimonthly newsletter serving the greenhouse industry, which is also available on the internet.

Edible coatings for greenhouse vegetables

This project's goal was to evaluate the use of different edible coatings on greenhouse vegetables to improve their shelf life. It was run in collaboration with Food Science and Technology, CDCS. Six different coatings were used including carnauba wax, shellac, Decco Lustre 227F, carboxymethylcellulose, calcium caseinate, whey protein concentrate, field pea starch, pea protein isolate, wheat gluten, and wheat flour coatings were prepared. Coated vegetables were stored at 4°C, 10°C, and 23°C. Weight loss during storage was used as a measure of moisture retention.

Vegetables coated with carnauba wax exhibited the greatest moisture retention at all temperatures; the greatest effect was at 23°C for both cucumbers and peppers. The addition of calcium chloride to shellac and carboxymethylcellulose coatings did not improve moisture retention. The calcium level in whole cucumbers coated with calcium fortified carboxymethylcellulose film increased up to 32%. Most of the applied calcium was retained by skin after a two-minute washing when stored at 10°C. Calcium fortified films did not change calcium level in cucumber flesh. The data indicated an apparent synergistic effect of calcium and food grade fungicides, sodium benzoate and potassium sorbate, on mold suppression in cucumbers stored for three weeks at 10°C.

The results of this study triggered collaboration with Noviant, USA, and largest CMC producer in the world. This project was supported by Red Hat Coop, which provided in cash contribution and ran in collaboration.

Selection of alternative substrates for production of greenhouse vegetables in Alberta.

The greenhouse industry in Alberta has traditionally used sawdust as a substrate because of its low price and availability. Sawdust provides appropriate growing conditions in the beginning of a crop, but losses stability and starts decomposing after 1-2 crops. The industry has started looking at new substrates like coconut fiber as a sawdust alternative. Four substrates, sawdust, rock wool, perlite and coconut fiber were compared as a growing media for peppers and cucumbers. All substrates showed similar results for peppers. Coconut fiber increased cucumber yield by 15%.

The preliminary experiments in 2002/2003 showed Zeolite amendments boosted yield by 10 to 15 per cent. This increase will allow Alberta greenhouse growers to considerably increase their profit margins and be more competitive. The used substrate containing Zeolite is valuable as a slow release fertilizer. There may be a potential for secondary use in tree nurseries. Red Hat Coop; Millenniumsoil Coir, Ontario; Industrial Mineral Processors and Alberta Greenhouse Growers Association (AGGA) supported the project.

Improved Management of Root and Stem Rot Diseases in Greenhouse Cucumber

This project is conducted in collaboration with plant pathology program at CDCS. Please visit that section of this report for more information.

Using hog manure composts with Zeolites

A new material for bedding plant substrate could use Zeolites as a component because of their unique ability to release ammonium and other nutrients. This new substrate is a mixture of Zeolite and hog manure compost. The materials complement each other by decreasing level of free ammonia and gradually releasing it according to the plant needs. The substrate could contain a higher content of nutrients per unit of

volume without toxic effect on plants. The new material is very stable when compared to sawdust and peat in bedding plant mixtures and has excellent physical properties including superior water retaining capacity. This will decrease shipping volume in retailing business and open new opportunities for hog manure applications. Preliminary results at CDCS showed high potential for Zeolite/compost mixes.

Evaluation and development of aquaponics production and market capabilities in Alberta.

Aquaponics is cutting-edge technology based on recycling nutrients produced by fish and growing high value organic vegetables without synthetic fertilizers. Aquaponics may reduce the risk of organic production in the greenhouse because it is a soil-free technology and is an excellent example of sustainable agriculture. The aquaponics project in Brooks is aiming to prove economic feasibility of the new technology in Alberta.

The Brooks Aquaponics Facility, BAF, has been built in retrofitted greenhouse with an assistance of Prof. J. Rakocy, University of Virgin Islands in the fall 2002. Theoretically, the system can to produce 2300 kg of fish a year and supply nutrients for up to 160 square meters of plant space. The first fish were introduced in December 2002; the first plants in January, 2003. The system has been in full operation mode since August 2003. After six months, the nutrients reached maximum level, which was comparable with that in commercial hydroponics facility.

Successful implementation of a slightly acidic growth medium (pH 6.0) prevented precipitation of major macro-and microelements, thus providing a good nutritional balance in the greenhouse. The low pH did not disrupt nitrification of organic waste material from aquaculture part of the system. The preliminary results indicate the potential to produce yields close to conventional hydroponics, kg/m^2/year:

Tomatoes	32.3		
Cucumbers mini (Alamir)	43.0	Cilantro Purdue	18.5
Egg plant	11.1	Parsley	22.8
Basil Genovese	30.2	Portulaca	17.2
Basil Lemon	13.0	Swiss Chard	68.7
Basil Osmin	6.8	Water spinach	75.5

The operation of aquaponics facility at CDCS demonstrated technical feasibility to produce yields of greenhouse vegetables comparable with commercial hydroponics and fish biomass comparable with a commercial fish operation.

Efficacy of precision placement carbon dioxide supplementation in greenhouse sweet pepper and long English cucumbers production

The program continued collaboration with Air Liquide in liquid carbon dioxide applications in greenhouse production.

The objective of the seventh year of the study was to reproduced the results of the 2002 study and demonstrate the benefits of liquid CO_2 applications when used at lower concentrations from 350 to 450 ppm. This was triggered by increased market prices on liquid CO_2. The results showed sustainable 10-15% increase in yield the same as 2002 results.

Cultivation and Assessment of *Lepidium campestre* as source of glucoraphanin

This project is conducted in collaboration with special crops program at CDCS. Please visit that section of this report for more information.

Cultivation and Assessment of rosemary as a commercial crop in Alberta

This project is conducted in collaboration with special crops program at CDCS. Please visit that section of this report for more information.

Sourcing qualified labor for greenhouse industry in Alberta

This project is conducted in collaboration with Agro-Food Investment Branch. Alberta's greenhouse industry increased from 138 acres in 1993 to 275 acres in 2003. The greenhouse industry is one of the fastest developing industries in Alberta and is ranked forth in Canada. The industry employs over 1500 full time and over 3,000 part time people. Currently, the industry is developing faster than the qualified labor market. According to the recent survey done by AAFRD, AAFC and Alberta Greenhouse Growers Association (AGGA), the lack of qualified labor is one of the major constraints for further growth of the industry. The greenhouse crops program is doing research to identify the problem and looking for other labor sources in Alberta and from two countries overseas. In cooperation with Alberta Economic Development, Economic Immigration Program and Human Rersource Development Canada, the greenhouse crops program started a process of preparing legal documents for pilot project to bring foreign labor from Mexico, Russia and Ukraine.

Initiatives of Greenhouse Crops Program

Greenhouse crops program and fruit and vegetables proposed the Alberta Nutri-Fruit and Vegetable Initiative. ANVI is a new umbrella organization aiming to coordinate activities related to quality enhancement and development of value added products in the fruit and vegetable industry. Projects under the ANVI umbrella include a feasibility study on vegetables enriched with calcium and the development of nutritionally enhanced edible coatings to improve the shelf life of vegetables. Using the positive result from these projects, Alberta's growers will be producing and marketing the first functional vegetables in Canada.

In November 2003, the greenhouse crops program in collaboration with fruit and vegetable and special crops programs invited Dr. Michael Grusak. Dr. Grusak has been recognized by scientific community for his remarkable contribution into the area of production of nutritionally enhanced food. Dr. Grusak was guest speaker at workshops at University of Alberta and AAFC – Lethbridge where he spoke about research in nutritionally enhanced crops in USA. He was also a participant in a round table discussion on Functional Food and Natural Health Products in U of A chaired by John Kennelly, Chair of Agriculture, Food and Nutrition Science Department, U of A.

Technology Transfer

The program leader N. Savidov, provided extension service to growers and department and industry personnel. Telephone and on-site consultations with greenhouse growers regarding crop management concerns and problems make up a large part of the extension activities. Transferring crop production expertise regarding new crops and improved production techniques and technology is also a strong component of the extension service.

In May, the greenhouse crops program at CDCS hosted an open house. Over 100 greenhouse growers and industry related representatives attended. This event was so successful, a second open house was held in conjunction with the special crops program in August.

Two workshops on greenhouse crop diseases were held in Red Hat Coop, Redcliff and Pik'n Pak, Lacombe for growers. These workshops were a team effort between plant pathology and greenhouse programs at CDCS.

Integrated Crop Management Specialist Extension Program

R. Dunn and T. Wallace

2003 Field Days and Tours

Numerous field days and tours were planned in cooperation with AAFRD staff, and industry partners Regional events were held at Acadia Valley, Oyen (2), Bow Island (2), Lethbridge (2), Picture Butte, Medicine Hat and Magrath. Staff participated and or spoke at 4 additional industry planned events. Total farmer contact is estimated at 450 and industry contact at 75.

Staff provided planning and instruction support at the Provincial Diagnostic Field School at Edmonton during the spring and summer. The field school was a huge success in 2003. An annual forage/feed teaching module was added to the field school's agenda. This module was a suuessful joint effort between Crop and Livestock Diversification Divisons plus the Western Forage Beef Groups and AAFC. The field school trained over 800 industry representatives, producers and department staff.

Demonstration and Research Support

Planning support was provided for field trials by CDCS research staff and Irrigation Branch staff. This included trials related to chickpea, mustard, corn, canola, forages and cereals at several sites including the CACDI Irrigation demo farm at Lethbridge.

Planning support and presentations were provided for numerous workshops conferences and meeting throughout the province. Major events included the Southern Alberta Conservation Association Conference and Trade Show in Lethbridge, the Capturing Feed Grain and Forage Opportunities Conference in Red Deer (186 industry and producer attendees).

Staff participated in 9 industry advisor meetings to clarify issues and develop strategies related to crop industry growth; mustard and Pulse, annual forages, pest issues and integrated crop management.

A direct result of the Federated Cooperatives Limited participation in the annual forage module at the Diagnostic Field School, two presenations on annual forages were requested. A speaker was invited to address their staff of agrologists and dealers at the FCL annual agronomy update in Saskatoon (80 attendees). In addition a speaker was asked to attend on of their producer appreciation meetings in Medicine Hat.

Planning support was also provided for demonstrations, field trials and activities of the Southern Applied Research Association and the Chinook Applied Research Association.

Planning and supervisory support was also provided for the southern Alberta component of the Fusarium Head Blight irrigation management study.

Training

Agronomic support and training was provided to AgInfo Centre staff through various training sessions, one on one conultation and electron delivery.

The feed and Fodder team organized several training events, at both provincial (Diagnostic Field School) and regional level (Winter Cereals), for industry agronomists and producers. The Feed and Fodder team began to develop by providing a training opportunity with AAFRD, AAFC and WFBG researchers. Agronomic training was provided to AgInfo Centre staff, ASEA Rural Extension Staff, AAFRD extension staff and AREC staff.

AAFRD extesnion staff contined with the InfoSynergy training model, working closely and learning from AAFC, AAFRD and WFGBG researchers. This partnership is a knowledge management tool, building AAFRD extension staff skills and knowledge plus staff profile as they replace researchers in high profile extension meetings.

Extension support

Presentations were prepared and given in response to over 40 requests for information or skill development related to cereal, pulse and oilseed agronomy or cropping systems.

Agronomic support and training was also provided to industry clients through one on one consultation and electronic delivery. This was provided in concert with provincial Ag-Info Center staff on cropping issues related to the southern Alberta area.

Nursery Crops Program

C. Murray and N. Seymour

The nursery crops program is focused on research into cultural management practices for commercial nursery production of both field and container-grown plants and the evaluation of new plant cultivars. Technology transfer activities include seminar presentations, magazine articles and research reports directed to growers and other members of the nursery-landscape trades industry as well as potential growers. A close association with Landscape Alberta Nursery Trades Association (LANTA) allows for excellent communication with the nursery-landscape industry.

The program leader also provides information services to other AAFRD staff and to producer and commodity organizations. Details of research trials are presented in *Nursery Crops Program 2003*, CDCS Pamphlet 2004-8.

Research Projects

Plant Evaluation Trials

Regional Woody Plant Test Program

Since 1983, AAFRD staff, the LANTA Growers Group and Research Committees have cooperated to develop and maintain The Regional Woody Plant Test Program (RWPTP). New tree and shrub introductions, generally from North America, are evaluated for five years at six different sites representing different climatic regions in the province. Growth and landscape quality data are collected each year. Seven new selections were planted at each site in the spring of 2003 and three new selections were planted in the fall of 2003. Evaluation of the eleven graduates which were originally planted in 1998 were completed this year. One graduate to note was *Viburnum lantana* 'Mohican', a shrub with attractive foliage and attractive white flowers scored excellent in most locations.

For more information about the RWPTP from 1983-2003 see *Regional Woody Plant Test Project, Summary Report 2003, CDCS Pamphlet #2004-3* or on the internet at <http://www.agric.gov.ab.ca/crops/trees/rwptp/index.html>.

Prairie Regional Trials

The Prairie Regional Trials (PRT) were established in 1958 to evaluate the hardiness of woody plants on the Canadian Prairies and continue today in cooperation with AAFC - Morden, MB. The plants in the PRT are evaluated for five years at seven prairie sites including CDCS. The growth and landscape quality data collected each year are sent to Morden where a report is produced approximately every three years and is now available at the internet website <http://res2.agr.ca/winnipeg/prt59_58.html>.

In 2003, there were no new plants added to the trial. In 1998, seven *Juniperus* sp., one *Larix* sp., one *Thuja* sp. and one *Taxus* sp. were planted and the evaluation was completed in the fall of 2003. *Taxus media* 'Hicksii' was an unsatisfactory selection for southern Alberta, while the other species planted in 1998 were recommended.

Alberta Perennial Gardens

In response to the huge growth in interest and sales of herbaceous perennials, the Calgary Zoo and Botanic Garden, LANTA Retail Operators Commodity Group and CDCS cooperated to develop the perennial demonstration and evaluation garden from 1999-2001 at the Calgary Zoo in the Dorothy Harvie Gardens. A second phase of the trial began in the spring of 2002 with addition of demonstration gardens at the Olds College Botanical Gardens, Olds and at the Muttart Conservatory, Edmonton. The project objectives are:

- to evaluate new species and cultivars of perennials for hardiness and landscape quality under Alberta conditions;
- to compile and publish the results for the public, retailers, growers and landscape professionals.
- to increase the knowledge about new perennials.

The summary of the data collected from 1999-2001 has been published in the technical document, *Perennial Trial Garden Evaluation 1999-2001*, and a general audience brochure. Both are available from the LANTA Retail Operators Commodity Group. Results are also available on the Alberta Agriculture Web site. <http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/opp7204?opendocument>

University of Saskatchewan Perennial Trial

The University of Saskatchewan (U of S) is evaluating perennials for the prairies. Overwintering the material is one of the most crucial factors in selecting suitable cultivars. To obtain overwintering data in different climate zones, the selections are grown and evaluated in different locations.

In cooperation with the U of S, CDCS is evaluating overwintering success of 9 Dianthus, five Asters and 10 Geranium selections were received and planted in the fall of 2002 for observations over two seasons.

The evaluation of six systems of holding harvested trees during the shipping season.

Caliper trees are harvested in a short period that begins with spring thaw and ends when the trees leaf out. There is a need for trees in the landscape industry from spring thaw to winter freeze up; thus, thousands of trees are held by growers across Alberta during the growing season.

Maintaining the quality of the trees during this period is important for trees to retain their value, continue to grow and transplant successfully. When trees are harvested, then balled and burlapped, as little as 5% of the root system is retained within the rootball. The remaining small root system must provide sufficient water and nutrients for the top to continue to grow and to produce replacement roots for those lost at harvest. This while the tree is being held before transplanting to its final location. It is also important that the trees do not root out into the soil surrounding the rootball during this period. These newly developed roots are generally broken and destroyed by moving and shipping, resulting in a second transplant shock for the tree.

Brandon elm trees were harvested with a tree-spade, wrapped in burlap and placed in wire baskets and transported to CDCS early June 2002. They were placed in a holding area in one of six systems; 1) placed back into hole of the same size (control), 2) placed into hole of same size with dual layer plastic bag around rootball 3) placed back into hole with 1/3 of basket above ground 4) placed on surface of soil with dual layer plastic bag around rootball 5) placed on geotextile on soil surface and completely mulched with wood product 6) placed into hole of same size lined with geotextile. The trees were irrigated throughout the season.

Top-growth was measured in the fall of 2002. Roots were harvested and dried. They were separated into the root mass 10 cm inside the original rootball and the root mass growing outside of the rootball into the surrounding soil or mulch. Half the trees were harvested in the fall of 2002 and the remaining in the spring of 2003. No significant differences were found in the growth rates or in the root mass inside the rootball. The root mass outside of the rootball was significantly greater for the mulched treatment (T5) than the remaining treatments, followed by the 1/3 above ground treatment (T3) and the control (T1).

This trial was repeated in 2003 to measure the impact of the holding system had on the success of transplanting into the landscape. Harvested Brandon elms were placed in the holding area in the same treatments as 2003. Growth was measured on the trees but the roots were not harvested. The trees will be planted in the landscape in 2004 where growth measurements and observations will be taken during the growing season of 2004 and the spring of 2005.

Chickadee birch grafting trials

Betula papyrifera 'Chickadee' is a hardy white birch selection with narrow crown, bright white bark, and brilliant yellow fall color. However, its hard-to-root character has limited its availability in the landscape trade. Attempts to propagate Chickadee birch by hardwood and softwood cuttings has resulted in little rooting success. *Betula* species are more difficult to propagate through alternative methods of asexual propagation such as budding and grafting because in the spring, the extensive sap flow in birch prohibits grafting until the development of the second leaves at which point sap flow is reduced.

This purpose of this trial was to develop a protocol for propagating *Betula papyrifera* 'Chickadee' with grafting. Two year old white birch seedlings were lined out in a plot on May 21, 2002. Scionwood of Chickadee birch was collected in March, 2003 and wrapped in moist paper towels and kept dormant in a freezer until grafting took place. By May 27, the seedlings in the field had developed second leaves and the first grafting treatment was done. Grafting was completed at two more dates at two week intervals. The scion was grafted onto the rootstock by bark-grafting.

There were very few successful grafts for any of the treatments, 20% or less. This method has been unsuccessful during two years of research indicating that this method of propagation of Chickadee Birch is not economically feasible and other methods should be explored.

Preliminary trial for using Zeolite as a component of media for container nursery crops.

Zeolites are microporous crystalline solids with well-defined structures. Generally they contain silicon, aluminium and oxygen in their framework and cations, water and/or other molecules within their pores. Many occur naturally as minerals, and are extensively mined in many parts of the world. Others are synthetic, and are made commercially for specific uses, or produced by research scientists trying to understand more about their chemistry. Zeolites reduce nutrient loss due to leaching by increasing the retention of the nutrients and slowly releasing them as needed by plants. Discarded greenhouse substrate with incorporated zeolites is a potential nutrient source and component of container media as the zeolites will retain nutrients the greenhouse crops could not access.

Rooted *Potentilla fruticosa* 'Coronation Triumph' cuttings were potted into #2 pots. Media was composed of: Treatment 1, 45% peat:45% perlite/zeolite mixture:10% sand, Treatment 2, 45% peat:45% perlite/zeolite mixture:10% sand with slow-release fertilizer added and the control 45% peat:45% sawdust:10% sand with slow-release fertilizer added. The perlite/zeolite mixture used in the media had been used to grow greenhouse crop and then discarded. The mixture contained 10% zeolite.

Treatment 1, without fertilizer, resulted in less plant growth compared to both the control and Treatment 2.

Plant collections

Plant collections have been developed and maintained at CDCS as a living reference collection for use by horticultural professionals and the general public. The **Golden Prairie Arboretum** was established in 1981 at CDCS. The collection now contains 312 species of 68 genera for a total of 531 deciduous trees and shrubs. These plants represent most of the deciduous woody plant species that can be grown on the prairies. A complete listing of the collection is available in *Golden Prairie Arboretum, ASCHRC Pamphlet 93-1.*

The **Forever Green Pinetum** collection of coniferous trees and shrubs at CDCS was established in 1986. At present it contains 26 species of nine genera for a total of 120 trees and shrubs. A complete listing of the collection is available in *Forever Green Pinetum, ASCHRC Pamphlet 93-12.*

The **Rose Garden** contains 241 specimens, many of which are unique to the CDCS collection. Many early Canadian rose cultivars and notable crosses of Canadian rose breeders, Skinner, Bugnet and Wallace are maintained in the collection. Routine maintenance was carried out in these areas.

Technology Transfer

Technology transfer to the growers is accomplished through work with the LANTA Growers Group, Western Nursery Growers Group, nursery visits as well as by the production and distribution of the Nursery Crops Trial Report, magazine articles and the presentation of seminars. Also the leader, C. Murray, traveled with the Western Nursery Growers Group to tour top nurseries and garden centres in the Cleveland Ohio area July 2003.

Plant Pathology Program

R.J. Howard, K.F. Chang, S.L.I. Lisowski, D.A. Burke and D.L. Slomp

The plant pathology program conducts applied research on economically important diseases of forage, horticultural and specialty crops. These studies involve field, laboratory, growth chamber, controlled environment storage and greenhouse experiments, as well as disease surveys.

Research Projects

Diseases of Fruit Crops

Management of rust and powdery mildew on black currants

A field survey was conducted in 2003 at 14 locations to assess levels of powdery mildew (*Sphaerotheca mors-uvae*) and white pine blister rust (*Cronartium ribicola*) on black currants (*Ribes nigrum*). Twelve commercial orchards in central and southern Alberta had rust; an average of 22% of the plants were infected. Ben Alder and Ben Lomond, the two most commonly grown cultivars in Alberta, were highly susceptible to this disease. Ben Tirran was moderately susceptible. In many cases, 100% of the

plants were infected and significant late-season defoliation resulted. Three commercial orchards in central and southern Alberta had powdery mildew and ca. 63% of the plants were affected. Ben Alder and Ben Lomond were highly susceptible to this disease and up to 100% of the plants were infected. Premature bud breaking resulting from mildew infection was seen in one orchard in southern Alberta. This survey was done in cooperation with Dr. I.R. Evans, Agri-Trend Agrology Ltd., Edmonton, and Dr. Ken Fry, ARC-Vegreville.

Diseases of Greenhouse Crops

Efficacy of RootShield for the prevention of root and stem rot in greenhouse cucumber

The principal objective of this new study, with funding from BioWorks, Incorporated, Fairport, NY was to assess the efficacy of RootShield (Plantshield HC) [*Trichoderma harzianum* Rifai strain KRL-AG2] for preventing and/or reducing *Pythium* infection in cucumber. RootShield was given a temporary registration in Canada in 2002 by the Pest Management Regulatory Agency.

This project was completed as five separate studies to identify a highly virulent *Pythium* species to use for inoculation studies, to find the most effective inoculation method and dosage to use for *Pythium* applications to cucumber seedlings in rockwool blocks, and finally to quantify an optimum dosage and timing for RootShield applications. A virulent isolate of *Pythium aphanidermatum* was identified from amongst several *Pythium* spp. tested. It was applied as undiluted and diluted (1:10) cornmeal/sand medium to cucumber seedlings. RootShield @ 225 g/m^3, applied either three days in advance of seeding, or three days before a potential exposure to *Pythium*, i.e. when setting cucumber seedlings onto substrate bags, provided some measure of protection against root and stem infections. However, plant growth was slightly stunted by this high dosage of RootShield, and it was not effective against high levels of *Pythium* inoculum.

Improved management of root and stem rot diseases in greenhouse cucumber

This is a three-year joint project of this program, the greenhouse crops program, greenhouse business development, CDCN, the Alberta Crop Industry Development Fund, Alberta Professional Horticultural Growers and Congress Foundation Society, and several industry partners. The primary purpose of this study, which began in 2003, is to develop improved management practices that will reduce disease losses and increase economic returns to greenhouse cucumber producers.

Surveys of cucumber greenhouses in central and southern Alberta were completed in cooperation with Dr. Piara Bains, Agri-Research Ltd., Edmonton. The purpose of these surveys was to determine the distribution and economic impact of root and stem rot diseases on cucumbers and to document possible sources of infection. The surveys showed that root and stem rot was problematic in the many greenhouses and that improved management practices were needed. Gummy stem blight and powdery mildew were also serious in some operations.

Another purpose of this project is to determine the effectiveness of new disease management technologies. A SeAir Nutrient Oxygen Diffuser, a mechanical water treatment device, was evaluated for the control of root and stem rot pathogens. Two machines were installed in a CDCS greenhouse. They produced microbubbles of oxygen, which diffused into the nutrient solution. The purpose of this trial was to see if these enhanced levels of oxygen would improve plant growth, decrease disease levels and improve fruit yield. A cucumber crop was planted with half of the house on sawdust and half on cocopeat bags. Half of the bags of each substrate received oxygenated nutrient solution and half not, and half were inoculated with *Pythium* and half not. These four treatments were evaluated for plant health and yield. Preliminary results were encouraging, with decreased mortality and higher yields in cucumbers plants inoculated with *Pythium* and grown on sawdust bags fed with a nutrient solution

diffused with oxygen, as compared to inoculated treatment without oxygen. Two workshops were held at Redcliff and Gull Lake in December to disseminate disease management information and project results to growers.

Survey for diseases on greenhouse pepper

Staff from CDCS and 20/20 Seed Labs Inc., Brooks surveyed six southern Alberta pepper greenhouses for fusarium stem and fruit rot, Pepper Mild Mottle Virus and other diseases in 2003. Some very interesting problems were found, including striping on fruit, and puckering, chlorosis and edema on leaves. Investigations of the cause of these problems are continuing.

Survey for Pepino Mosaic Virus in greenhouse tomato

Pepino Mosaic Virus (PepMV), a highly infectious viral disease of tomato, was confirmed in two Alberta greenhouses in 2003. A PepMV alert bulletin and fact sheets describing how to identify and control this disease were distributed to greenhouse tomato growers.

Diseases of Nursery Crops

Survey for black knot on *Prunus* species in Alberta

A field survey was conducted in 2003 to assess the geographical distribution and economic importance of black knot, a fungal disease caused by *Apiosporina marbosa*, in wild and cultivated plantings of *Prunus* species (plum family). Surveyors visited a variety of habitats, including orchards, amenity plantings, parks, boulevards, research collections, nurseries, natural areas, arboreta and shelterbelts in 27 locations. A disease index was calculated for each site to quantify the incidence and severity of infection. In general, the nurseries had a very low disease incidence. However, many other types of habitats, especially yards and parks in some urban areas, had a very high rate of infection. Samples of knots were collected from each site and sent to Dr. D.L. Fernando at the University of Manitoba for strain typing.

Diseases of Potato

Efficacy of seed treatment fungicides against silver scurf and verticillium wilt

An interim report of this trial was presented in the 2002 Annual Report, but data analysis was not completed. Analysis revealed that levels of verticillium wilt in this trial were very high due to abundant seed- and soil-borne inoculum; therefore, none of the seed treatments tested, which included Senator and ENG0500, significantly improved plant emergence or reduced wilt symptoms compared to the control. Data from the silver scurf trial indicated that these same fungicide treatments did not significantly improve emergence or tuber yield or reduce silver scurf incidence or severity compared to the inoculated and non-inoculated checks.

Resistance of potato breeding lines to early blight under field conditions

Twenty-eight advanced breeding lines and four cultivars, including two standards from the Western Canadian Potato Breeding Program based at AAFC, Lethbridge, were screened for resistance to early blight (*Alternaria solani*) and alternaria blight (*A. alternata*) in a naturally infected field trial at CDCS in 2003. Three visual estimates of incidence and severity for both the field canopy and compound leaf samples were taken in late August and the first half of September, when disease levels were highest. Although several of the breeding lines appeared promising, no single entry consistently exceeded Russet Burbank in terms of resistance to alternaria blight and early blight.

Cross-Canada fungicide efficacy trial against three storage diseases

These trials were performed in 2002-2003 cooperatively with Dow AgroSciences, Guelph, ON and focused on two foliar fungicide combinations: Gavel 75 DF + Dithane and Dithane + Gavel 75 DF in comparison to four other fungicides (alone or in

combination): Dithane DF, Omega SC + Dithane DF, Ridomil Gold EC + Bravo 500SC + Dithane DF, Acrobat MZ + Dithane DF, and an untreated control The objectives were to assess whether the two Gavel 75 DF treatments applied during the growing season would delay or prevent the onset of late blight, leak and pink rot, as compared to the other four treatments, and also to determine if the disease development differed between six commercial potato fields in four provinces. These sites all received identical foliar fungicidal treatments during the growing season. In the fall, tubers were received from the six fields: BC and MB with two sites/province and QC and PEI with one site each. In addition, tubers from a second experiment which had been treated with a Gavel 75 DF + Dithane DF combination, were received from QC (1 site), NB(3 sites) and PEI (1 site). All tubers were held in a controlled environment storage room at CDCS without any further fungicide treatment until evaluations took place in 2003.

Late blight – Inoculation with *Phytophthora infestans* resulted in moderate to high levels of late blight infection in tubers from all of the sites. No fungicide treatment consistently reduced disease severity compared to the inoculated control. Gavel + Dithane was the top-performing product at three of the six sites for the six fungicide trial, but at only one of the five sites for the Gavel + Dithane trial.

Pink rot – Inoculation with *Phytophthora erythroseptica* resulted in moderate levels of disease in tubers from all six sites for the multi-fungicide trial, but no treatment consistently reduced the disease severity compared to the inoculated control. Gavel + Dithane, Ridomil Gold + Bravo + Dithane, and Omega + Dithane were the best products at two sites each. No significant differences were seen between the test fungicides and inoculated control for any of the five sites in the Gavel + Dithane trial.

Leak – Inoculation with *Pythium ultimum* showed that no individual fungicide consistently reduced disease severity compared to the inoculated control; however, Ridomil Gold + Bravo + Dithane consistently had amongst the lowest severity values. Gavel + Dithane, Omega + Dithane and Acrobat + Dithane also exhibited low levels of disease. No significant differences were observed between the test fungicides and inoculated control for any of the five sites in the Gavel + Dithane trial.

Efficacy of seed piece treatments against black scurf and silver scurf

The efficacy of an experimental fungicide-insecticide combination (L1210 + L1049) against seed-borne rhizoctonia black scurf/canker and silver scurf was evaluated in a trial at CDCS in 2003, in cooperation with Gustafson Partnership. This mixture was applied as a seed piece treatment at two rates and compared to Senator and an untreated control. Stand counts were taken on three dates. In August, some of the plants were dug and evaluated for rhizoctonia canker, and an initial black scurf rating was performed on the tubers. After harvest, the tubers were bagged and weighed to obtain yield data, then placed into storage for ca. four months. The final black scurf and silver scurf ratings on the stored tubers will be performed in January, 2004. Data analysis is pending

Evaluation of Quadris, Bravo and Allegro for the control of early and alternaria blights

The efficacy of three foliar fungicidal treatments (Bravo 500F, Quadris 250SC and Allegro 500F), used either alone or in combination, were evaluated against early blight in a field plot at CDCS in 2003. These treatments were compared to other fungicide combinations, i.e. Headline 250 EC, Polyram, Bravo 720, Ridomil 480 SL and Ridomil Gold. All fungicides were applied to the foliage at ca. seven-day intervals on a rotational schedule. The first spray application was made on July 22, when *Alternaria solani* inoculum was applied to the guard rows, which were not treated with fungicides. The inoculum was reapplied on August 21. Combined levels of alternaria blight and early blight in both the crop canopy and on samples of compound leaves from each subplot were recorded on three dates between August 18 and September 2 using a visual rating scale. The crop was harvested on October 6. Both marketable and total yields were recorded. None of the fungicide foliar treatments significantly improved tuber

yield or reduced early blight incidence / severity compared to the untreated check. The very hot, dry weather during the summer was not conducive to blight infection. In addition, soil inoculum levels were very low as this was the first blight trial ever done in this plot.

Evaluation of fungicides for the control of alternaria blight and early blight on irrigated potatoes in southern Alberta

This trial was conducted in two commercial potato fields in southern Alberta. The objective was to determine whether using only Syngenta Crop Protection Canada products was more effective against alternaria and early blight than using commercial products of the grower's choice, which may or may not include Syngenta products. Each field was ca. 55 ha (140 ac) in size and pivot-irrigated. One-half of one of the sites was treated with Syngenta products, including two new products, Maxim PSP and Quadris 250 EC, while the other half was treated with the farmer's choice of commercially available products until August 4. The other farmer also used similar Syngenta fungicides and commercial products, but only applied them until July 4. Natural levels of *Alternaria* inoculum were relied upon for infection. Disease levels were assessed at each site on three dates during the growing season, and compound leaf samples were collected from each half of the fields for evaluation. Blight levels were very low, and significant levels were only found on the last sampling date. Conflicting data were obtained for this trial, with one site showing significantly less early blight on the half treated with Syngenta products compared to the commercial products. The reverse was true with the second site, but since fungicide treatments ended relatively early for that field and the early blight only showed up at the end of August, the residual effects of the fungicide treatments may have been negligible by that time.

Long-Term Storage of Creamer-Sized Gourmet Potatoes

The objective of this study, funded by the Little Potato Company, Edmonton, was to determine the effects of long-term storage of creamer-sized gourmet potatoes (19-41 mm) and to find the best conditions for prolonged refrigerated storage. The varieties Bintje, Nordonna and Blue were received at CDCS in January 2003. The bags were weighed and placed into a controlled environmental storage room at 5°C and 93% RH. Evaluations began in May and included assessments for shrinkage, infectious and non-infectious diseases. The evaluations continued at monthly intervals for a total of five months. In general, the tubers stored very well over the course of the study, with the exception of the Blue potatoes, which were mostly diseased.

Diseases of Pulse Crops

Apron Maxx RTA research permit trial on dry bean

A research permit field trial for Apron Maxx RTA seed treatment for controlling seed decay and damping-off caused by *Pythium* spp., *Fusarium* spp. and *Rhizoctonia solani* in dry bean was conducted at CDCS. Apron Maxx RTA was compared to Maxim 480 FS + Apron FL + copper sulphate pentahydrate, Thiram 75WP + Apron FL, and an untreated check. An *in vitro* analysis was also carried out on acidified and plain potato dextrose agar to compare fungal and bacterial colonization of the treated and untreated seeds. Naturally occurring soil-borne microflora did not cause levels of damping-off or root rot that were sufficient to differentiate the seed treatments from the untreated check. For the *in vitro* analysis, Apron Maxx RTA performed as well as Maxim 480 FS + Apron FL + copper sulphate pentahydrate, and Thiram 75WP + Apron FL. Some of the seed treatments also exhibited bactericidal or bacteriostatic properties.

Apron Maxx RTA research permit trial on chickpea

A research permit field trial for Apron Maxx RTA seed treatment for controlling seed decay and damping-off caused by *Fusarium* spp., *Rhizoctonia solani* and *Pythium* spp. and ascochyta blight caused by *Ascochyta rabiei* in chickpea was conducted at CDCS. Apron Maxx RTA was compared to Maxim 480 FS + Apron FL and an

untreated check. An *in vitro* analysis was also carried out on acidified potato dextrose agar to compare fungal and bacterial colonization of the treated and untreated seeds. Apron Maxx RTA performed as well as Maxim 480 FS + Apron FL in the field trial. The seed was infested with high levels of saprophytic bacteria and fungi, which the chemical seed treatments did not control.

Analysis of American-grown dry bean seed for bacterial pathogens

Forty small lots of dry bean seed imported from the Central Bean Co., Quincy, WA (1 cultivar, 3 seed lots), Kelley Bean Co., Rupert, ID (1 cultivar, 7 seed lots), Rangen Inc., Buhl, ID (three cultivars, 11 seed lots), and Soranco Bean Products, Twin Falls, ID (4 cultivars, 19 seed lots) by the Agricore United Bean Plant at Bow Island, AB, were sent to CDCS for testing. Each cultivar/source combination was analyzed separately. 20/20 Seed Labs Inc., Brooks, carried out Dome tests for bacterial blight diseases on subsamples of untreated seed. In total, eight field trials were established with each trial being an individual cultivar sourced from a particular seed company. These trials were situated well away from other bean trials to avoid any possibility of cross infection with bacterial blight diseases, and on land that had not grown dry beans for several years. Each seed lot included a treated and untreated sample. The treated seed was coated with 5.0 % w/w Agricultural Streptomycin + 0.85 US fl. oz. Apron XL LS + 0.04 US fl. oz. Maxim 480 FS/100 lb. seed. These materials were applied at the seed source prior to shipment. All of the cultivars and seed lots emerged and yielded relatively well under the conditions of this trial. There were few statistically significant differences between seed lots for emergence and none for yield. In general, the quality of seed sourced from the four companies was very consistent and it appeared to be essentially disease-free.

Field validation of common bacterial blight resistance in six cultivars of navy beans

CDCS was one of five locations across Canada chosen for this study; the others were Guelph, ON, Morden, MB, and Saskatoon and Outlook, SK. Small lots of healthy seed of six cultivars of navy-type dry beans were obtained from Ridgetown College, University of Guelph, Ridgetown, ON. Two field trials were established in a similar fashion. One of the trials was inoculated four times in August with isolates of *Xanthomonas campestris* pv. *phaseoli*. For both the inoculated and non-inoculated trials, the CBB-resistant cv. OAC Rex had the best emergence, while the susceptible cv. AC Compass had the lowest emergence. The CBB-resistant cv. HR67-1675 also had a relatively low emergence rate. For the inoculated trial, the CBB-susceptible cv. Navigator and resistant cv. OAC Rex had the highest yields, while the susceptible cv. Envoy had the lowest. OAC Rex consistently had low disease incidence and severity ratings, which validated its status as a CBB-resistant cultivar under the conditions of this trial. HR67-1675 had severity ratings that were comparable to OAC Rex, but the incidence of CBB in HR67-1675 was more than double that of OAC Rex.

Evaluation of seed treatments for the control of rhizoctonia seedling blight of dry bean

Great Northern bean seed was treated with L1050, L0288, TFL RTU or Vitaflo 280, either alone or in combination with Allegiance. Nontreated seed was planted as inoculated and noninoculated controls. All treatments, except L0288 alone, markedly improved emergence over the inoculated control. Vitaflo 280, alone, improved yield compared to the inoculated control.

Evaluation of seed treatments for the control of rhizoctonia seedling blight of soybean

Seed of the soybean cv. Gaillard was treated with L1050, L0288, L1269 or with Vitaflo 280, either alone or in combination with Allegiance. Nontreated seeds were planted as inoculated and noninoculated controls. All seed treatments in the trial,

except L0288 alone, improved emergence and seed yield over the inoculated control. L1050 was more effective than both L1269 and Allegiance + Vitaflo 280.

Evaluation of seed treatments for the control of botrytis seedling blight on lentil

Seed of the lentil cv. CDC Milestone was treated with Apron Maxx or Crown. Nontreated seeds were planted as inoculated and noninoculated controls. All seed treatments in the trial provided protection against seedling blight caused by *Botrytis cinerea*.

Efficacy of foliar fungicides against ascochyta blight on chickpea

A field trial was conducted at CDCS to evaluate the efficacy of four foliar fungicides to control ascochyta blight on chickpea caused by *Ascochyta fabae*. Headline 250EC, Bravo 500, Quadris 250EC, and Dithane DG at two different rates, were applied in various combinations four times during July and August and compared to an untreated check. The subplots were artificially inoculated four times throughout July and August. Disease incidence and severity were assessed on four dates. There were no differences between treatments with respect to emergence, but all of the fungicide treatments yielded 67-127% better than the check. The fungicides significantly reduced disease incidence and severity compare to the check on most assessment dates. The Dithane DG + Headline 250EC + Dithane DG + Headline 250EC spray schedule performed noticeably better than most of the other treatment combinations.

Evaluation of seed treatments for the control of rhizoctonia seedling blight of chickpea

Seed of the chickpea cv. Xena was treated with L1050, TFL RTU or Allegiance, either alone or in combination with Crown, Vitaflo 280 or L0288. Nontreated seeds were planted as inoculated and noninoculated controls. All seed treatments in the trial, except for Allegiance, alone or combined with L0288, significantly improved emergence compared to the inoculated control. Vitaflo 280 + Allegiance and TFL RTU were the only products that significantly improved seed yield compared to the inoculated control.

Evaluation of seed treatments to control ascochyta seedling blight of chickpea

Ascochyta-infested seed (35%) of the chickpea cv. Chico was treated with L1050 or Allegiance, either alone as a control, or in combination with Crown or L0121. Treatment with Crown + Allegiance improved both emergence and yield compared to the Allegiance-treated control. Treatment with Allegiance + L0121 significantly improved yield, but not emergence.

Evaluation of seed treatments for the control of botrytis seedling blight on chickpea

Botrytis-infested seed of the chickpea cv. CDC Xena was treated with L1050, TFL RTU, Allegiance, Crown, Vitaflo 280 or L0288. Nontreated seeds were planted as a control. TFL RTU resulted in significantly greater emergence compared to Allegiance + Crown, Vitaflo 280 or L0288. Seed yield was comparable for all the products tested, except for Allegiance + L0288, which yielded significantly less than L1050 or Allegiance + Crown.

Evaluation of seed treatments for the control of botrytis seedling blight of chickpea

Seed of the chickpea cv. Chico was treated with Crown or Apron Maxx and planted at CDCS and ARC-Vegreville. Nontreated seeds were planted as inoculated and noninoculated controls. Seedling emergence was improved over the inoculated control by both the Crown and Apron Maxx treatments. Treatment with Apron Maxx resulted in greater emergence than with Crown. Seed yield followed the same ranking trend for the three treatments and the inoculated control at both sites, but differences were significant at Vegreville.

Chemical control of *Rhizoctonia solani* and *Fusarium* spp. on peppermint

Two field trials were established at CDCS to evaluate the efficacy of seven fungicide treatments on Black Mitchum peppermint (*Mentha* x *piperita piperita*). Seedlings were transplanted into the field in August of 2001 and the roots were artificially inoculated with *R. solani* and *Fusarium* spp. The seedlings were subsequently drenched around the crown area of each plant with Benlate 50WP, Botran 75WP, Easout 70WP, Maxim 480FS, Quintozene 75WP, Rovral 50WP, and Tilt 250EC. An untreated check was also included. In June, 2002, data were taken for survival rate of the seedlings and fresh weight measurements were taken on August, 2002. In July, 2003, fresh weight data were again taken. With respect to survival rate, the untreated check was significantly lower than all treatments for both trials. For fresh weight, Easout performed significantly better than Benlate, Botran, Quintozene and the untreated check for *R. solani*. Benlate and Tilt performed better than Quintozene and the untreated check against *Fusarium* spp. In general, *Fusarium* spp. was more virulent than *R. solani*. In 2003, fresh weight measurements showed that Easout performed better than the untreated check, Quintozene and Benlate, while Easout, Tilt, Rovral and Maxim performed better than Benlate against *R. solani*. There were no significant differences in fresh weights for *Fusarium* spp. In general, all fungicide treatments greatly improved seedling survival rate and marginally improved yield after the first harvest. The yield improvement was less pronounced for the second harvest.

Disease resistance of 25 Mint cultivars to *Fusarium* spp.

A field trial was established at CDCS to evaluate disease resistance of 25 *Mentha* spp. to *Fusarium* spp. Seedlings were transplanted into the field in July, 2002 and artificially inoculated with *Fusarium* spp. Survival rate data and fresh weights were taken in November, 2002 and fresh weight data was again taken in July, 2003. The cultivars that had the best seedling survival rate were Improved Spearmint [(*M. spicata* 'Kentucky Colonel' (*M. corditalia*)], USDA *Mentha* 552 (*M.* x *rotundifolia*), Paraguay and Austrian (*M.* x *gracilis*). In 2002, the cultivar that had the highest fresh weight was USDA *Mentha* 107 (*M. aqua*), while *Mentha* 179 (*M. rotundifolia*) had the highest fresh weight in 2003.

Cultivar, pathogen and straw cover interactions on mint

A field trial was established at CDCS to evaluate the interactions between two cultivars of *Mentha* spp., inoculation with *Fusarium* spp. and straw covering for winterizing. In August, 2002, a three-factor split-plot trial was established. The factors for cultivar were Scotch spearmint (*M.* x *gracilis*) and Black Mitchum peppermint (*M.* x *piperita piperita*). The seedlings from the appropriate subplots were artificially inoculated with *Fusarium* spp. at time of transplanting. On November, 2002, the appropriate subplots were covered with ca.15 cm of straw. The straw was removed in May, 2003 and survival rate and fresh weight data were taken in July. When examining the cultivar interaction for seedling survival rate, the peppermint performed significantly better than the spearmint. Regarding the cultivar and straw cover interaction for seedling survival rate, the straw cover treatment for the peppermint performed better than the other treatments, showing a high level of statistical significance. With the cultivar interaction for yield data, the spearmint performed significantly better than the peppermint. Using pathogen interactions for the yield data, the non-inoculated subplots performed significantly better than inoculated subplots. For the cultivar and pathogen interactions for yield, inoculation reduced the weights of the spearmint more than the peppermint. However, the straw cover improved the yields of peppermint more than spearmint with respect to cultivar and straw cover interactions.

In summary, spearmint was much more winter hardy than peppermint. Straw cover improved seedling survival rate and yield more than with peppermint covered. Although all non-inoculated subplots had much higher yields than the inoculated subplots, the spearmint was much more sensitive to the inoculum than the peppermint.

Fall foliar application of fungicides to control stolon rot in a commercial mint field

A field trial was established at Summertime Farms in Carmangay, AB on a commercial field of Scotch spearmint (*M.* x *gracilis*) in October, 2002 shortly after harvest to evaluate the efficacy of 12 foliar fungicide treatments. An untreated control was also included. The stolons and rhizomes were examined on selected plants and there were little or no differences between the treatments with respect to incidence and severity of stolon rot.

Diseases of Vegetable Crops

A comparison of soil inoculants and organic fertilizers for the production of field lettuce

The effectiveness of two soil inoculants and three fertilizers on the yield and quality of head lettuce was evaluated in a replicated field trial at CDCS. The products tested included JumpStart (a soil inoculant containing the fungus *Penicillium bilaii*), N-Fix + SoilBio (an inoculant mix comprised of humates, kelp and soil and N-fixing bacteria), Peruvian Seabird Guano (organic fertilizer), alfalfa meal (organic fertilizer),and ammonium nitrate 34.5-0-0 (inorganic fertilizer). An untreated check was also included in this trial. The yield and quality of lettuce from all treatments was satisfactory with few noticeable differences. However, there was a high incidence of drop, a disease caused by the fungus *Sclerotinia sclerotiorum*, in the trial and all treatments appeared to be equal for this disease. There was no significant yield differences between the treatments in this trial; however, all produced lower than average yields compared to the untreated control, with the lowest yields occurring with the two organic fertilizers. JumpStart demonstrated the lowest average yield of the soil inoculants.

Technology Transfer

Findings from this work and from the research of other scientists were presented to commercial producers, industry representatives and extension specialists through technology transfer programs and to the scientific community via papers and abstracts published in peer-reviewed journals, as well as by posters and oral presentations given at conferences. The plant pathology program also provided support services to crop production research and technology transfer programs at CDCS.

Potato Agronomy Research Program

M. Konschuh, S. Dalpé, and B. Pyke

Alberta's Potato Industry

The potato industry in Alberta has been expanding over the past several years. In 2003, more than 58,000 acres of potatoes were grown in Alberta. Of the total, 41,000 acres were planted for processing (fries and chips), almost 14,000 acres were planted to seed potatoes and 4,000 acres were planted as tablestock. There are three major fry processing plants in southern Alberta, two potato chip plants and a number of packers. The overall value of the industry in Alberta has been estimated at over $300 million dollars.

Potato Agronomy Research Program

The objectives of the program are to foster increased production efficiency and competitiveness of the potato industry in Alberta. The program's focus is mainly on issues affecting irrigated potato production for processing and tablestock (seed potato issues are addressed by Tricia McAllister at CDCN). The majority of the research trials are sponsored by industry or industry organizations. In 2003, approximately 50% of the trials were conducted in small plots at CDCS, while the other 50% were conducted in co-operator fields near Scandia, Vauxhall, Taber and Grassy Lake. It is easier to control experimental parameters in small plot trials, but yield estimates and crop quality are often more relevant in grower controlled settings.

Research Projects

Timing of power hilling for Russet Burbank in Southern Alberta

Sponsored by the PGA

This project compared not hilling with conventional and power hilling at regular intervals after planting to determine how much damage and yield loss is sustained as a result of late hilling operations. Potatoes were graded for total yield, marketable yield, deformities, greening and internal defects. In 2003, all hilled treatments resulted in greater total yield than the control (not hilled). The greatest total and marketable yield were observed when potatoes were power hilled at emergence, but the best fry quality was observed from treatments power hilled when plants were 5 to 12 cm tall. If power hilling has not been completed by the time tuber initiation begins, disc hilling may result in a better combination of marketable yield and good fry color than power hilling late. A second year of the study is planned for 2004.

Potato vine management with desiccants

Sponsored by Syngenta

This trial was an industry sponsored comparison of Reglone to Ignite as desiccants on Russet Burbank potatoes. Rate of desiccation, skin set, yield, internal defects, fry color and sugar ends were assessed at harvest and after 4 months of storage. Timing of desiccant application had a greater impact on total and marketable yield than the type of desiccant used. A final report will be prepared in March 2004.

Effect of MH60 on sizing in french fry potatoes

Sponsored by Crompton Corp. and Lamb Weston- off site trial

Royal MH60 has been marketed as a growth regulator applied in-season to potatoes to provide sprout inhibition in storage. Recently, claims that MH60 can improve grade and quality of potatoes increased interest in the product. MH60 (maleic hydrazide) was applied to commercially grown Russet Burbank potatoes at three stages of tuber

development to determine if it was possible to increase the percentage of potatoes in the 6 to 10 ounce range without sacrificing yield. Potatoes were harvested and graded at CDCS and in a commercial lab to determine the effectiveness of MH60 applications. Timing of Royal MH60 application is critical for size control in Russet Burbank potatoes. Tubers from potatoes treated with MH60 were more blocky than tubers from the control (untreated) treatment. Application of MH60 to a Russet Burbank crop in early September resulted in greater total yield, and greater yield of tubers between 4 and 10 ounces than the control. A report will be prepared once the storage data has been analysed and compiled.

Effect of MH60 on sizing in chipping potatoes

Sponsored by the PGA and Frito-Lay- off site trial

Royal MH60 has been marketed as a growth regulator applied in-season to potatoes to provide sprout inhibition in storage. Recently, claims that MH60 can improve grade and quality of potatoes increased interest in the product. MH60 (maleic hydrazide) was applied to commercially grown Norvalley potatoes at three stages of tuber development to determine if it was possible to increase the percentage of marketable potatoes without sacrificing yield or specific gravity. Potatoes were harvested and graded at CDCS and in a commercial lab to determine the effectiveness of MH60 applications. Timing of Royal MH60 application is critical for size control in Norvalley potatoes. Application of MH60 when tubers were 5 cm in diamter improved specific gravity and chip score without reducing the yield of marketable tubers. Application of MH60 in early September resulted in a slight improvement in gross yield and good chip scores without increasing marketable yield. A report will be prepared once the storage data has been analysed and compiled. A second year of the trial is planned for 2004.

Effect of vine management on Russet Norkotah skin set

Sponsored by Agristar- off site trial

This trial compared single or split applications of Reglone, alone or following vine rolling or shredding, with complete vine removal and green harvesting of Russet Norkotah. Rates of tuber bulking and vine desiccation were monitored. Skin set, yield, grade and tuber quality were evaluated for each treatment. Data analysis is in progress and a report prepared.

Effect of variety, vine management, and storage temperature on appearance of red skinned fresh market potatoes

Sponsored by Agristar

This study was a comparison of three varieties of red-skinned fresh market potatoes (Norland, Sange and Nordonna) for skin set at harvest and skin color retention in storage. Applications of desiccant, alone or in combination with vine rolling or shredding, were compared with complete vine removal and green harvesting for manipulating skin set.

Variety influenced the maturity of red-skinned potatoes most, but skin set was also affected by the method of desiccation used. The influence of storage temperature on skin color retention is currently being examined for each variety. Data analysis is in progress and a report will be prepared.

Western Canadian Potato Breeding Program Regional Trials – Early, Maincrop and North Central Trials

In cooperation with AAFC - Lethbridge

As part of AAFRD's ongoing support of the Western Canadian Potato Breeding Program and the role it plays in the growth of the potato industry, early crop (80 and 95 day harvests) and maincrop regional trials and a North Central Trial for the Western Canadian Potato Breeding Program are done at Brooks.

Eleven varieties were evaluated against check varieties (Atlantic, Norland, Russet Norkotah, and Norvalley) approximately 80 days after planting and again approximately 95 days after planting in the early crop trial.

Twenty-three varieties were evaluated against check varieties (Atlantic, Norland, Norkotah, Ranger Russet, Russet Burbank, Sangre and Shepody) in the maincrop trial. Data were collected on 30 to 40 agronomic and quality factors including yield, maturity, specific gravity, culinary and processing quality.

Twenty-three lines were grown as part of a North Central trial comparing breeding material from Alberta with that of programs located in the north central U.S.A. Four of the varieties evaluated against the check varieties (Norland, Atlantic, Red Pontiac, Russet Burbank, Russet Norkotah, Norvalley and Snowden) have come out of the Western Canadian Potato Breeding Program. (CV89023-2R, Pacific Russet, V0379-2, and V0056-1). Data for these trials is provided to the Potato Breeder at AAFC - Lethbridge.

Variety demonstration of Pacific Russet as a fresh market alternative to Russet Norkotah

Sponsored by Agristar and ASPI - off site trial

A variety demonstration plot (120' x 6 rows) was planted in a commercial Russet field near Vauxhall. Comparisons were made between Pacific Russet and Russet Norkotah with respect to skin set, appearance, yield, and grade out. Pacific Russet is an early-maturing, attractive russet skinned potato for the fresh market. In the trials, Pacific Russet was ready to harvest approximately two-weeks ahead of Russet Norkotah and appeared to out-yield Russet Norkotah.

Syngenta Spud Solutions Sites 2003

Sponsored by Syngenta- off site trial

This was the second year of a Syngenta initiative. It was done in two commercial fields of Russet Burbank potatoes. The study involved a large-scale comparison of potatoes treated exclusively with Syngenta products (seed treatment, foliar fungicides, desiccant) with potatoes treated with competitor products. Assessments were made on emergence, stand count, Rhizoctonia stem and stolon canker, early blight, late blight, black scurf, yield and tuber quality. A full report has been compiled.

Technology Transfer

Information was provided by the program leader, M. Konschuh, to producers, processors, and other industry staff as requested. Information about cultivar evaluations and research projects was presented at industry meetings and through direct contact.

The majority of the extension responsibilities for the potato industry are handled by Lori Delanoy, AAFRD extension agronomist.

Soil and Water Agronomy Program

S.A. Woods and L. Hingley

The soil and water agronomy program conducts research on water, fertilizer and sustainable soil quality requirements of special crops, horticultural crops and irrigated forages. Some research projects were done cooperatively with staff from other programs at CDCS and other divisions of AAFRD, including the Conservation and Development (C&D) Branch and the Canada-Alberta Crop Development Initiative (CACDI).

Research Projects

Soil salinity tolerance of potatoes

In 2003, a one-year project was done in collaboration with staff from the Irrigation Branch. The study, of a 6 ha (15 acre) plot of Russet Burbank potatoes, was conducted at the CACDI research site, near Lethbridge, AB. The objectives of the study were to map the topography and soil salinity of the site and to quantify the effects of soil salinity on the field-scale crop of potatoes.

Mapping was done (April 16) using differential global positioning satellite (DGPS) equipment along with the Geonics™ EM38 meter. Concentrations of salts followed the topography of the area. There was a "slough-ring" effect occurring at the north and west corners of the quarter, where salinity has been concentrated in discharge areas. A yield monitor was successfully adapted to the potato harvester used at the site. However, due to the high clay content of the soil, excessive clumps of soil were picked up by the harvester and these confounded the data collected at the load-cells (scales at the top deck of the harvester). At times, less than 25% of the material passing across the scales was potato tubers. Twenty hand samples of tubers were collected just prior to harvest, representing the full range of salinity at the site. Samples were graded and analyzed for specific gravity. A previous study on Russet Burbank potatoes showed that tuber yields declined by more than 25 % when salinity increased from 1 dS/m to 3 dS/m. At this site, however, no yield response to increasing salinity was shown. In field studies of salinity tolerance, results are often confounded by other variable field conditions, such as moisture, fertility, disease, weeds and insects. In this case, the early timing of the harvest may also have affected results.

Long term viability and salinity tolerance of dryland forage and turf grasses

A field experiment, to determine the salinity tolerance of 20 species of forage and turf grasses, was established in 1991, by the soil and water agronomy program on a farmer's field, near Oyen, AB. Due to drought conditions, the plot was abandoned in 1992. In 2002 and 2003, the site was revisited to determine the long term viability and salinity tolerance of the species tested. Plans to collect plant samples in the late summer of 2002 were prevented by a grasshopper infestation and counts of healthy plant clusters were taken instead. Another grasshopper infestation at the site, in 2003, prevented an early harvest, however, forage samples were collected from four species in July 2003, crested wheatgrass and Altai, Russian and Dahurian wildryes. Salinity and topography maps of the plot and surrounding area were also made in July 2003. Superior drought tolerance and persistence were exhibited by the four species that germinated and survived in sufficient quantities to be sampled. Overall, the Dahurian and Russian wildryes showed the greatest tolerance to soil salinity in 2002 and 2003.

Mapping of Crop Diversification Centre South

Salinity, topography and plot maps were made, in 2002, for Lendrum Farm and portions of MacLeod Farm, using the soil and water agronomy program's GPS and EM38 equipment. During the 2002, season, access to fields was limited due to excess moisture conditions and plot locations. In 2003, mapping was completed at MacLeod Farm and the Bow Island sub-station. The purpose of this project was two-fold;

- to determine the distribution and severity of soil salinity at the three research sites and
- to establish a baseline for monitoring long-term changes in soil salinity.

The benefits of this project include the production of soil salinity and topographic maps, which can be used by researchers to determine the most appropriate location and plot design for their crop research at CDCS. The maps will also indicate whether or not local influences are contributing to any salinity problems and what measures can be taken to remediate the effects of the soil salinity. A draft report has been prepared and, when complete, will be distributed to CDCS staff.

Protocol and technology for soil salinity mapping

This project is a collaboration with staff from the C&D Branch from Edmonton and Lethbridge. The purpose is to develop a provincial protocol for salinity mapping and assess the accuracy and practicality of a variety of soil salinity mapping hardware and software, in order to increase province-wide precision and compatibility in production recommendations from salinity map data. With the new legislation surrounding feedlot operations, it is expected that the EM38 and salinity mapping will be used for monitoring soil salinity on lands where manure is being disposed. The team expects that the use of salinity mapping technology by the private sector will increase. It is important that standards for comparison are set now. An initial planning meeting and two field tests (May and September) were conducted in 2003. New software for simultaneously collecting GPS and EM38 data was also commissioned and tested by the soil and water agronomy program in 2003. The software was produced by Roberton Enterprises Ltd., of Calgary. The software was found to be robust and suitable for the program's research needs. It is hoped that, in the future, the software can be expanded for use with the Geonics™ EM31, in order to expand the soil and water program capabilities in salinity mapping, to a greater range of soil depths.

Affects of frozen soil on electromagnetic inductance

Electromagnetic inductance is a rapid and accurate means for estimating soil salinity. It can be used in conjunction with GPS to create soil salinity maps or it can be used alone to estimate soil salinity at benchmark locations. One electromagnetic inductance meter in current use is the Geonics™ EM38. The EM38 can be used to estimate soil salinity in two modes, vertical (0-1.5 m depth) and horizontal (0-0.75 m depth), which approximate the rooting depths of perennial and annual crops, respectively. The meter is affected by ions in the soil (including salts, water and metal) and by soil temperature. Caution must be used when using the meter when soil is partially or completely frozen. In the fall of 2003, an experiment was began to test the efficacy of the EM38 on freezing and frozen soils. The vertical and horizontal EM38 readings, at five benchmark sites, across a wide range of salinities, will be monitored throughout the winter. At this site, there are five salinity values and two water application rates. Laboratory analysis was done on soil cores for calibration of the inductance meter readings. The effects of soil temperature and frozen soil on EM38 readings will be presented at the 2004 Alberta Soil Science Workshop.

Effects of topography and soil horizonation/layering on long-term solute transport under semiarid conditions

Understanding of solute transport through the vadose zone in semi-arid environments (e.g., Canadian Prairie) is limited. The objective of this study is to compare the relative influence of topography and soil horizonation on the spatial

variability of water and solute transport after 34 years under transient, unsaturated, semi-arid conditions. In 1966, a chloride tracer (as KCl) was applied to plots (6 m x 90 m, Chernozemic soil) near Saskatoon, SK. In 2000, a total of 202 soil cores (6 m depth) were taken from a transect, across one of the plots. The soil horizonation/layering of each core were recorded. Each core was sectioned (0.1 m intervals) and samples (N>12000) were analyzed for chloride concentration, bulk density and soil water content. Historic sampling indicates that the chloride center of mass was at a depth of approximately 1 m after 4 years. After 34 years, the chloride center of mass is at approximately 2.75 m in slight convex areas, compared to 1.70 m in level areas. There is significantly faster transport in depressional areas, which is attributed to rainfall and snowmelt re-distribution. The influences of subtle changes in surface topography and soil horizonation/layering on the average depth and spread (vertical and lateral) of the chloride tracer continues to be studied. This project is the soil and water agronomy program leader, S. Woods' PhD. thesis research, which was part of the program's succession plan. In 2003, figures and tables were completed and writing began. Laboratory analysis of undisturbed soil samples began in late 2003, to determine the hydraulic functions of the soil layers present.

Technology Transfer

Soil and water information was provided to a diverse audience through papers, posters and presentations. Presentations were made at producer tours and inquiries were answered through telephone contacts, office visits and correspondence.

Information on methods of soil salinity measurement and crop tolerances to salinity were provided to various groups, including a lecture to Olds College students, a field demonstration and a class lecture at the University of Lethbridge (Geography 4760: Agricultural Soil Management) and tour presentations for CDCS visitors, including the AAFRD Executive and Minister Shirley McLelland.

The program leader edited a peer review article on the salinity tolerance of cotton, for the journal Computers and Electronics in Agriculture (COMPAG).

Special Crops Program

M. Bandara, C. Weisbach, A. Fox, F. Scharf, J. Webber and E. Russell

The special crops program at CDCS is primarily responsible for the evaluation, introduction, and development of new crops and agronomic practices for southern Alberta through applied and adaptive research. Some study projects are conducted in partnership with other CDCS research programs, other AAFRD divisions, University of Alberta (U of A), University of Saskatchewan (U of S), AAFC, Regional Research Associations and industry partners. The Agriculture Funding Consortium, regional variety testing programs and also several industry partners provide the financial support for the program.

Research Projects

Chickpea and lentil crop improvement program

In 2001, a five-year crop improvement project for chickpea and lentil was initiated at the Crop Diversification Centre south, Brooks in collaboration with the Crop Development Centre, University of Saskatchewan, Saskatoon, Saskatchewan, where F_1 and F_2 generations of both crop species raised. The main objective of this project is to develop new chickpea and lentil cultivars for southern Alberta under dryland conditions with specific selection criteria of high seed yield, early flowering early and uniform maturity, resistance to common foliar and root diseases and desired market traits.

Lentil and chickpea $F_{2:3}$ generation seed received from the CDC and seed of $F_{2:4}$ and $F_{2:5}$ generations of chickpea and lentil selected under field conditions in southern Alberta in previous years, were planted for further evaluation and selection at CDCS A total of 54 micro-plots were harvested based on desirable growth habits and crop maturity. Using seed quality and days to maturity, 5 lines of the small Kabuli-type and 24 of the Desi were selected for further evaluation in 2004.

Twenty-eight chickpea $F_{2:1}$ small plots were established at CDCS. Seed material derived partly from the $F_{2:3}$ in 2002 (6 Desi and1 Kabuli) and partly from the $F_{2:3}$ in 2001 (5 Desi and 6 Kabuli) were included. Using plant growth traits, yield components and plant maturity, 4 Desi and 3 Kabuli chickpeas were selected for further evaluation.

Twenty-six chickpea $F_{2:5}$ standard plots were planted at two locations, Bow Island sub station and CDCS. Using plant growth traits, yield components and plant maturity, 6 Desi and 5 Kabuli chickpeas were selected for further evaluation in 2004.

One hundred and fifty-eight lentil $F_{2:4}$ micro-plots were planted at the Bow Island sub station. A total of 31 out of 79 small green entries and 41 out of 79 red lentil entries were harvested based on desirable growth habit and crop maturity characteristics. Using seed yield and quality, 17 entries from each small green and red lentil types were selected for further evaluation in 2004.

Twenty-six lentil $F_{2:4}$ standard plots were planted at two locations. Bow Island sub station and CDCS. Using plant growth traits, yield components and plant maturity, 2 large green and 8 red lentil lines were selected for further evaluation.

Twenty-six lentil $F_{2:5}$ standard plots were grown at two locations. Bow Island sub station and CDCS. All were of the red lentil type. Using plant growth traits, yield components and plant maturity, 6 lines were selected for further evaluation in 2004.

Fall vs. spring seeding of desi chickpea

Fall seeding, or dormant seeding, refers to the planting of spring crop species in the fall, prior to freeze up. A field study was conducted in 2002/2003 cropping season at CDCS, using the desi chickpea cultivar Myles. Treatments included two late fall seeding dates, Nov. 8 and Nov. 22, 2002, and two early spring dates, May 02 and May 21, 2003. The seeding rates were, 1 time, 1.5 and 2.0 times the recommended seeding rates for uncoated seed, and the recommended seeding rate for plastic polymer-coated seed (Grow Tec Inc. Edmonton, Alberta, Canada) for each fall-seeded treatment. Spring seeding was done at the recommended seeding rate.

On average, fall-seeding treatments had no significant effect on final plant height, harvest index or mean seed weight of chickpea compared to the spring-seeded crop. However, on average, later spring-seeded crop produced significantly heavier seed than early spring-seeded crop. Increasing seeding rate of fall-seeded treatments consistently increased both plant population density and seed yield, but the effects were significant only in the later fall-seeded treatments.

Plant population density of the fall-seeded uncoated seed at recommended seeding rate was comparable with the fall-seeded plastic polymer seed coat treatment, which was about 69% of the actually seeded density (55 seeds m^{-2}). This indicates the plastic polymer seed coat treatment had no beneficial effect on seedling establishment of the fall-seeded chickpea crop.

The earlier spring-seeded crop produced about 11.6 % higher seed yield than the later spring-seeded crop, but the difference was not significant. The earlier fall-seeded crop using the recommended seeding rate produced significantly lower seed yield than the earlier spring-seed crop, but it comparable with that of later spring-seeded crop. Lower stand establishment of the earlier fall-seeded crop may have been the main reason for this yield reduction. Higher soil moisture conditions due to a rainfall received after the earlier fall seeding may have injured some seeds during the ground freeing process. Among the later fall-seeded treatments, the treatments with 1.5 and 2.0 times seeding rates produced significantly higher seed yield, compared to the both spring-seeded crops. This indicates that for enhanced seed yield from the fall-seeded Myles chickpea, the crop should be seeded in very late fall at 1.5 times recommended seeding rate. On average

plants from the fall-seeded treatments flowered and attained maturity 15 days and 10 days, respectively earlier than the spring–seeded crop.

In summary, results indicate late fall seeding of desi chickpea can be practiced in southern Alberta. Since the conclusions are based on results of two-season single-site study, comprehensive studies covering a wide range of soil and climatic conditions in the Brown and Dark Brown soil zones, are required before fall seeding can be recommended in southern Alberta.

Impact of seed size planted on crop phenology and seed yield

The size of the seed planted, has been shown to have a significant impact on seedling establishment, seedling vigor and crop growth of several small-seeded field crops like mustard, coriander and carrot. In contrast, other studies have reported that the seed size had no significant impact on plant growth and development, and final seed yield of large-seeded crops such as chickpeas. Two separate studies were conducted at CDCS to examine the effect of the size of seeds planted, on seedling growth, seed yield and seed size profile of the resulting crop of four kabuli chickpea and four pinto bean cultivars under field conditions in southern Alberta.

Kabuli chickpeas

Three large-seeded kabuli chickpea cultivars, Sanford, Evans and CDC Xena, and one small-seeded kabuli cultivar, CDC Chico were used for this study. Seed of each chickpea cultivar were screened into two size categories, large-seeded cultivars, <8.7 mm and >8.7mm and small-seeded cultivar, < 8.1, and > 8.1 mm). These treatment combination (cultivar x seed size) were seeded at the recommended seeding rate (55 seeds m^{-2}). In addition, another treatment using smaller seed category of all chickpea cultivars at 1.2 x recommended seeding rate was included.

The chickpea cultivars differed in plant height, seed yield components and seed size distribution, but the size of seed planted had no significant impact on most of the parameters measured. Despite the phenological differences, the lack of a significant impact of seed size planted, on plant growth, seed yield components and seed yield suggests that smaller seed of kabuli chickpea can be used for planting without affecting seed yield or the seed size profile of the resulting crop. Moreover, the use of smaller seed category at higher seeding rate, 1.2 x recommended seeding rate, had no significant effect on seed yield. This assumes the reduction in seed size is not due to disease infected seed or immature seed. A germination test should be done. If smaller seed category is used for planting, growers could reduce their seed cost due to reduced seeding rate and transportation cost. At the same time, the larger seeded portion of the crop can be sold at a premium for human consumption.

Pinto bean

The seeds of the four cultivars, Othello, Fargo, CDC Pintium and CDC Pinnacle, were screened into four size categories, <7.1 mm, 7.1-7.9 mm, 7.9-8.7 mm and > 8.7 mm in diameter. These seed categories of the 4 bean cultivars were seeded at the recommended seeding rate of 55 seeds m^{-2}. A treatment using the 7.1 –7.9 mm seed category at 1.3 x recommended seeding rate was also included.

On average, the size of seed planted had no significant impact on seed yield, final plant height, test weight or plant population density. Results indicate that smaller seed categories can be used for seed purpose without having any adverse impact on seed yield, while larger seed categories can be used for human consumption. Moreover, use of the 7.1 –7.9 mm seed category at 1.3 x recommended seeding rate had no benefit to seed yield of the resulting crop.

Evaluation of rosemary as a potential medicinal plant for Alberta

Rosemary (*Rosmarinus officinalis* L.), is a slow growing, cold sensitive, woody perennial cultivated for the aromatic foliage. It is used primarily as a culinary herb with meats, vegetables and soups. In traditional medicine, the plant is used as an astringent, diuretic, and to increase menstrual flow. Interest increased in using rosemary extracts as

a source of antioxidants in commercial food preparations. Rosemary production feasibilities and growing requirement information under prairie conditions is limited. Several field studies were conducted:

- •To evaluate the possibilities of growing rosemary as an annual crop under field conditions at CDCS,
- •To evaluate the impact of freezing temperatures and killing frost on plant growth and antioxidant content in rosemary,
- •To evaluate effect of age of the rooted stem cutting planted on growth and productivity of rosemary,
- •To evaluate the effect of planting density and soil nitrogen content on plant growth, productivity and product quality of rosemary.

In a cultivar evaluation study, seven promising of rosemary cultivars, Apr, Blue Boy, Majorca, Santa Barbara, Severn Sea, Standard and Rex were planted using 8-week-old rooted stem cuttings at CDCS. The field was fertilized with 12:51:0 (N:P:K) fertilizer mixture at a rate of 42 kg ha^{-1}, prior to the final land preparation. The crop was grown under irrigation. All the compound extractions and chemical analyses were done by Norac Technologies Inc., Edmonton, AB.

Rosemary cultivars Standard and Arp were the tallest (38 –40 cm), Rex, Majorca and Severn Seas were intermediate (26-38 cm) and Santa Barbara and Blue Boy were the shortest (8-11 cm) at 13 weeks of age. Rosemary cultivars Rex, Majorca and Severn Seas produced significantly higher total aboveground biomass, whereas Blue Boy produced significantly lower biomass, compared to Standard. In rosemary, foliage portion is the most important plant part since it contains over 85% the total antioxidant content. Therefore, the leafiness, dry weight ratio between foliage portion and the total above ground portion is more important than the total aboveground biomass production.

Results also suggests that leafiness of both rosemary cultivar Blue Boy (88%) and Santa Barbara (81%) are significantly higher than the cultivar Standard (75%) when those cultivars are 18 weeks old. The total antioxidant contents varied, from 3.9% for Blue Boy to 4.8% for Standard, among cultivars at 13 weeks of age. However, following a light frost at 18 weeks and killing frost at 20 weeks of age the antioxidant content slightly reduced in Standard, Rex, Apr and Severn Seas, but the antioxidant contents in Majorca, Santa Barbara and Blue Boy did not change, compared to that of 13-week-old plants.

Results indicated that despite the fact that antioxidant content slightly lowered as a result of aging, light or killing frosts in aforementioned cultivars, Rex (2.08-2.26%), Majorca (1.88-1.86%) Standard (1.51-1.59%) and Severn Seas (1.57-1.43%) were still superior in terms of total antioxidant production under field production, due mainly to higher foliage production. Thus these cultivars can also be harvested with no adverse impact on the total antioxidant yield, even after light or killing frosts.

A study to evaluate the impact of age of rooted stem cutting in plugs, on plant growth, productivity and plant mortality of rosemary cultivar Majorca was conducted using 4-, 6- and 8-week-old rooted stem cuttings. The stem cuttings were transplanted at a spacing of 60 cm x 20 cm. Cultural practices adopted were similar to that of the rosemary cultivar study.

Results indicated that age of rooted stem cuttings had no significant effect on plant height or diameter of field-grown 13-week-old plants. The total above ground biomass production of the plants raised from 8-week-old plants was significantly higher (13%) than that of the plants raised from the 4-week-old stem cuttings. However, age of rooted stem cuttings had no impact on leaf production. Those plants raised from 8-week-old stem cuttings produced significantly higher stem dry weight than the plants raised from 4-week-old rooted stem cuttings. This suggests that the above ground biomass increase in the plants raised from 8-week-old stem cuttings, was mainly due to enhanced stem production. The use of 8-week-old rooted stem cuttings as a planting material for field establishment, appears to have no additional benefits in terms of leaf production, compared to the use of 4-week-old rooted stem cuttings. Thus four-week-old rooted stem

cuttings can be used as a planting material for field production of rosemary.

A study was conducted to evaluate the effect of planting density and soil nitrogen content on crop growth and antioxidant yield in rosemary cultivar Majorca. The cultural practices were similar to that of the cultivar evaluation study. A basal fertilizer mixture, N:P:K=12:51:0, at a rate of 42 kg/ha^{-1} was applied at prior to final land preparation. Treatments included two plant population densities, 60 cm x 20 cm = 83,333 plants ha^{-1} and 30 cm x 20 cm=166,666 plants ha^{-1}, and two nitrogen rates, 50 and 100 N kg ha^{-1} arranged in factorial structure and control plots with a plant population density of 83, 333 plants ha^{-1} with the basal fertilizer application.

Results indicated that both applied nitrogen and plant population density had no significant effect on plant height, diameter, total above ground biomass, leaf and stem production, and antioxidant content. The highest leaf production and antioxidant yield were observed from the plants grown at a spacing 30 cm x 20 cm at 50 N kg ha^{-1} and increasing N rates from 50 to 100 N kg ha^{-1} had no beneficial effect on either leaf production or antioxidant production.

Evaluation of field pepperweed (*Lepidium campestre* L.) cultivars for glucoraphanin production

Recent studies have shown a reduction in blood pressure, atherosclesrotic-like changes and a reduction in stroke and heart diseases in a rodent system model, following the ingestion of broccoli sprouts with high levels of glucoraphanin. Furthermore, field pepperweed was found to contain a significant level of glucoraphanin in leaves. Several studies were conducted to evaluate and select most promise field pepperweed accession/s, in terms of biomass productivity and glucoraphanin content under greenhouse conditions, to determine the best growing condition and processing practices for higher glucoraphanin yield.

In the greenhouse, seven accessions received from USDA, ARS, Iowa State University and a local collection from Acadia Valley, AB, were evaluated for glucoraphanin content and productivity. Results indicated that aboveground biomass production of different accessions varied from 5.2 to 35.6g/ plant^{-1}; the accession Ames 13179 produced the highest biomass and the local collection produced the lowest biomass. Glucoraphanin content of accessions varied from 3.1to 180.8 µm/FW g^{-1}. The accession Ames 13179 contained the highest and the local collection contained the lowest glucoraphanin content. The accessions Ames 13179, Ames 15718 and Ames 13180 were found to be most promise accessions in terms of glucoraphanin production under greenhouse conditions.

In the growth chamber a study was done to determine the impact of growing conditions (12/12h day/night, 24/6°C ; 12/12h day/night, 24/12°C ; 16/8h day/night, 24/ 6°C and 16/8h day/night, 24/12°C) on plant growth and glucoraphanin content. On average, under short day conditions (12/12h day/night), field pepperweed produced significantly higher number of leaves/plant, and lower aboveground biomass when plants were grown under warmer nights (12°C) than those grown under cooler nights (6°C). Under long day conditions, cooler nights (6°C) were favorable for leaf production compared to warmer nights (12°C), but night temperatures had no impact on above ground biomass production. On average, plants growing under short day conditions, had significantly higher glucoraphanin content when grown under cooler nights than those grown under warmer nights. However, under long day conditions, night temperatures had no significant impact on glucoraphanin content. On average, accession Ames 15718 was superior in terms of glucoraphanin production compared to other accessions, and for higher glucoraphanin production, Ames 15718 should be grown under short day with cooler night conditions.

A study was conducted to examine the impact of crop growth stage on glucoraphanin content using Ames 13179. Results indicated that young seedlings at the 1-2 true leaf stage did not contain glucoraphanin in leaves. However, as the plant attained 40 days of age, the leaf glucoraphanin content had reached 874 µg/DW g^{-1}, but

as plants get older (50 days), the glucoraphanin content has dropped by 44%, indicating that 40- day-old plants would be the most suitable growth stage of harvest for the highest glucoraphanin content.

Two separate studies were conducted to determine the impact of pre- and post-harvest stresses imposed on plants, on glucoraphanin content of field pepperweed. The pre-harvest stress study was conducted using Ames 13180 and post-harvest stress study was conducted using 3 field pepperweed accessions Ames 13179, Ames 13180 and Ames 15718. The pre-harvest stress treatment imposed at full-rosette stage by maintaining water content at 50% field capacity for 3 or 6 days, or irrigating plants with 150 mM NaCl for 3 or 6 days, prior to harvest. Plants grown at field capacity served as the standard controls (water control).

Drying the harvested leaves at room temperature for 4 days, prior to extraction of the glucoraphanin, imposed post-harvest stress. The salt treatment applied for 3 and 6 days enhanced the leaf glucoraphanin content by 39% and 66%, respectively over the water control. Conversely, water stress treatment applied for 3 and 6 days reduced glucoraphanin content by 15.5% and 18%, respectively, compared to the water control. On average, desiccation treatment enhanced glucoraphanin content by over 3.4 times compared to the fresh leaves. The response to the desiccation treatment, however, was accession specific. The treatment enhanced the glucoraphanin content by 6, 3 and 2 times in Ames 15718, Ames 13180 and Ames 13179, respectively, compared to the corresponding controls. Salt stress imposed through 150 mM NaCl treatment for 6 days prior to harvest of the crop could be used as a means of enhancing the glucoraphanin content in field pepperweed. Moreover, desiccation of leaves at room temperature prior to extract could enhance the glucoraphanin content. Ames 15718 was the most promise accession in terms of glucoraphanin productivity, thus this accession may be useful for further evaluation.

Evaluation of the effect of rhizobacterial isolates on the activity of rhizobial inoculants and growth promotion of field pea, lentil and chickpea.

Pulse crops play a vital role in crop rotations on the Canadian Prairies as they increase profitability by eliminating the need for nitrogen fertilizer due to their ability to fix atmospheric nitrogen. Industry sponsored field studies were conducted at CDCS, to examine the effect of Rhizobacterial isolates on the activity of Rhizobial inoculants in relation to root nodulation and seed yield in field pea, lentil and chickpea. The confidentiality agreement signed between the project sponsor (Becker Underwood, Saskatoon, SK.) and AAFRD does not allow publishing the results of these studies in this report.

Crop selection and improvement

Seed of borage, *Echinacea angustifolia*, *E. pallida* and *E purpurea* and peppermint, spearmint and Alaskan mint stolons were treated the mutagenic compound, Ethyl Methanesulphonate (EMS) in 2000. Treated seeds and stolons were planted in plugs or pots and placed in a greenhouse. In early spring, both *Echinacea* and mint species were transplanted into the field. *Echinacea* species are being visually evaluated for Aster Yellows disease resistance. Mint species are being evaluated for over wintering ability and essential oil content. Foliage of individual mint plants raised from the treated stolons was used to extract essential oil. Crop selection based on essential oil content, oil composition and over-wintering ability is in progress.

The seed harvested from borage plants raised from EMS-treated seed were planted in spring 2003 in the field for selection and seed multiplication. Based on maturity, borage plants were categorized into several groups and further selection is in progress based on seed shattering, and seed oil content.

Regional cultivar evaluations

Newly recommended cultivars and promising lines of chickpeas, dry beans, field peas, lentils and fababean received from various pulse breeding programs are evaluated under growing conditions in southern Alberta, to select the most promising cultivars for the

region. The emphasis of the dry bean cultivar testing is on yield performance, early maturity and architecture of a dry bean plant that allows for narrow row configurations, direct combining and consequently an expansion of dry bean production to areas in Alberta. Majority of bean cultivars/lines for this evaluation receives from the dry bean crop improvement programs at the AAFC - Lethbridge and CDC at the U of S.

Several cultivars/lines of silage and grain corn were established for regional adaptation. Both silage and grain corn performed very well under both Bow Island and Brooks growing conditions.

Evaluation of new pulse crop species

Seed of unnamed and named lines of mung bean (*Vigna radiata* L. Wilczek), black gram (*Vigna mungo* L. Hepper), moth bean (*Vigna aconitifolia* Jacq.) and pigeon pea (*Cajanus cajan* L. Millisp.) were planted in the research field at CDCS in mid May. 2003. Mature seed from selected plants of all the new pulse species, except pigeon pea were harvested. Further evaluation and selection will be conducted in 2004.

Technology Transfer

Program staff continued to answer numerous inquiries on the production of special crops, particularly on herb, spice and essential oil crops. Several field days and workshops were organized and research information was contributed on special crops to producer newsletters and the news media. Test plots of various special crops including pulse crops and medicinal herbs at CDCS and Bow Island were visited by a large number of interested individuals and groups. Extension staff and other interested parties were provided with planting materials for demonstration and field testing to assist herb, essential oil and spice producers evaluate new crops.

Meteorlogical Report

N.G. Seymour

The Alberta Agriculture, Food and Rural Development's Crop Diversification Centre South (CDCS) operates two automated weather stations; one at the Centre southeast of Brooks and another at the sub-station southwest of Bow Island.

Brooks (CDCS)

Precipitation is measured with two instruments at the Brooks station. The Tipping Bucket Rain Gauge (TBRG) very accurate in reading rainfall to 0.2 mm is not reliable for recording snowfall. The Fischer-Porter Weighing Gauge (F&P) provides an accurate reading for snowfall equivalent. 2003 was a dry year for the Brooks area compared with the thirty year average and during the growing season it was very dry in July and August while June and September was close to the average.

The final spring frost of 2003 occurred on May 19 (-5.0°C). The first autumn frost was –0.5°C on September 17 (-2.2°C on Septembr 18). giving a total of 120 frost-free days in 2002. This is higher than the 30-year average (1951-80) of 116 frost-free days (May 21 to September 15).

	Temperatures (°C)								Precipitation (mm)		
	Extremes		Average				Means		2003		1971-2000
	Max	Min	Max	30 yr av	Min	30 yr av	2003	30 yr av	TBRG	F&P	30 yr av
January	13.0	-35.7	-2.8	-5.6	-14.6	-17.0	-8.7	-11.3	n/a	6.5	14.7
February	6.5	-31.3	-3.0	-2.7	-14.8	-14.1	-8.9	-8.4	n/a	1.30	12.2
March	21.7	-33.2	2.8	3.7	-9.7	-7.8	-3.4	-2.1	n/a	6.3	19.5
April	25.1	-9.8	12.7	12.7	-.01	-1.7	6.3	5.5	29.2	33.6	27.9
May	30.5	-5.0	16.4	18.9	3.1	4.2	9.8	11.6	28.6	34.6	44.1
June	32.2	1.0	21.8	23.1	9.0	8.8	15.4	16.0	59.0	64.7	58.8
July	35.1	4.1	28.4	25.7	11.1	10.9	19.7	18.3	9.4	7.8	41.7
August	34.5	4.0	28.6	25.0	11.8	9.7	20.2	17.4	13.4	11.3	39.3
September	32.2	-3.2	19.1	18.8	4.8	4.2	11.9	11.5	33.8	32.3	39.4
October	29.0	-20.6	15.9	13.6	.07	-1.1	8.3	6.3	25.4	31.2	17.0
November	5.3	-29.5	-2.9	1.9	-15.6	-9.7	-9.3	-4.0	n/a	11.4	14.7
December	6.2	-20.5	-2.1	-4.2	-12.1	-15.7	-7.1	-9.9	n/a	0.7	18.9
Average	22.6	-15.0	11.2	10.9	-2.2	-2.4	4.5	4.2	TOT n/a	235.4	348

Bow Island (Sub-station)

The last recorded frost was -1.7°C on may 19 and the first autumn frost (-0.8°C) occurred on September 17, for a total of 120 frost-free days in 2003, three days less than the 30-year average (1951-80) growing season at Bow Island of 125 days (May 17 to September 20).

The precipitation recorded during the summer months indicates lower than average moisture for the growing season in Bow Island particularly in July and August. It is important to note that precipitation is only measured with a tipping Bucket Rain Gage which is unreliale during the winter months.

	Temperatures (°C)								Precipitation (mm)	
	Extremes		Average				Means		2003	1971-2000
	Max	Min	Max	30 yr av	Min	30 yr av	2003	30 yr av	TBRG	30 yr av
January	15.1	-31.5	-.05	-5.2	-12.6	-15.9	-6.5	-10.6	2.3	18.6
February	8.6	-32.8	-2.7	-.09	-13.9	-11.7	-8.3	-6.3	5.6	11.3
March	18.9	-33.6	2.7	4.7	-8.8	-6.6	-3.0	-.09	4.3	13.1
April	23.8	-8.8	13.0	12.5	0.9	0.2	7.0	6.6	31.7	34.2
May	30.6	-2.5	16.2	19.2	4.5	5.5	10.3	12.4	30.0	44.9
June	31.8	3.5	21.7	24.4	9.8	10.7	15.7	17.6	60.5	69.8
July	33.2	4.8	27.5	27.6	10.8	12.1	19.2	19.7	4.1	30.9
August	35.9	2.7	28.5	27.1	12.2	11.9	20.3	19.6	2.8	32.4
September	33.6	-3.4	18.5	20.2	5.4	5.6	12.0	12.9	23.4	30.4
October	27.0	-20.6	15.9	15.0	1.3	0.5	8.6	7.6	10.2	12.3
November	6.5	-27.7	-1.8	4.7	-12.7	-6.6	-7.3	-1.0	5.8	12.8
December	8.1	-17.5	-0.1	-2.8	-9.1	-13.0	-4.6	-7.9	0.0	19.0
Average	22.8	-14.0	11.6	12.2	-1.0	-0.6	5.3	5.8	TOT 180.7	330

Staff Publications and Presentations

Research Reports

Bandara M. 2003. Evaluation of the effect of rhizobacterial isolates on the activity of Rhizobial inoculants and growth promotion of field pea, lentil and chickpea. Final Report submitted to the Becker Underwood, Saskatoon, SK. pp.23.

Calpas, J. T., M. Konschuh, S.L. Liswoski, S.L. Mathur, C. Toews and J.P. Tewari. 2003. Development of a biological control for the gray mold pathogen. *Botrytis cinerea* Pers.:Fries in greenhouse tomato. Alberta Agriculture Research Institute Project #19980818.

Chang, K.F., R.J. Howard, S.F. Blade, C. Neeser, L. Hausher, and K. Fry. 2003.

Diseases of currant and gooseberry in central and southern Alberta in 2002. Can. Plant Dis. Surv. 83: 135-136.

Chang, K.F., S.F. Hwang, R.J. Howard, G.D. Turnbull, and S.F. Blade. 2003. Occurrence of ascochyta blight and root rot diseases on chickpea in Alberta in 2001 and 2002. Can. Plant Dis. Surv. 83: 103-104.

Chang, K.F., S.F. Hwang, R.J. Howard, M. Bandara, S.F. and Blade. 2003. Study of etiology and management mint stolon rot in Alberta. Final Report of FFF Project #2000M645, Alberta Agricultural Research Institute, Edmonton, 56 pp.

Driedger, D. and M.N. Konschuh. 2003. Yellow Discoloration of Potato Flesh. Phase II: Chemical differences between yellow and white Russet Burbank potatoes and effect of temperature stress on Russet Burbank flesh color. ACIDF Project Report 2002C112N.

El Hafid, R., S. Meyer, S. Oliveira, Y. Peng, C. Neeser, N. Savidov, D. Driedger, R. Hockridge and H. Aitlammanlam. 2003. Feasibility Assessment of Producing And Commercializing Calcium-Fortified Vegetables In Alberta: A report for the Alberta Agriculture, Food & Rural Development Industry Development Sector New Initiative Fund, Edmonton, June 2003, pp. 99.

Howard, R. J. and S.L.I. Lisowski. 2003. Efficacy of RootShield for the prevention of root and stem rot in greenhouse cucumbers. Final Report to BioWorks, Inc., Fairport, NY.

Konschuh, M.N. and S. Dalpé. 2003. Agronomy research for wedge cut potatoes: Seed physiology, in-row spacing and harvest timing for Russet Nugget and V0852-2 potatoes to optimize yield of tubers suitable for wedge cut fries. Report for Maple Leaf Potatoes, Lethbridge Alberta. 16 pp.

Murray, C.L., J. Andrews, O. Johns, W. Daley, J. Helder, S. Wotherspoon, and H. Childs. 2003. Alberta Perennial Trials, Interim report. ACIDF #2002C055R, March.

Murray, C.L. and N.G. Seymour. 2003. Nursery Crops Program 2002. #2003-8. March

Murray, C.L. and N.G. Seymour. 2003. Nursery Crops Program 2002. #2003-8. <http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/opp7658?opendocument>

Murray, C.L. and N.G. Seymour. 2003 The evaluation of six systems of holding harvested trees during the shipping. season. <http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/opp7141?opendocument>.

Murray, C.L. and N.G. Seymour. 2003 Evaluating Woody Plants for Hardiness and Landscape Quality in Alberta. <http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/opp4045?opendocument>.

Najda, H.G. and A. Kruger. 2003. Western forage testing system report. 116 pp.

Najda, H.G. and A. Kruger. 2003. Western Canadian grass seed testing program. Annual Report. 33 pp.

Neeser, C., M. Webber and B. Kruger. 2003. Tolerance of Sensitive Crops to Everest® Residues the Year Following Application. Report prepared for Bayer Crop Science Canada, May 2003, pp. 12.

Neeser, C., T. Pheh and M. Webber. 2003. The influence of Accent® on the performance of three sweet corn cultivars.

Neeser, C., T. Pheh and M. Webber. 2003. Black Currant Cultivar Trial 2002.

Neeser, C., T. Pheh and M. Webber. 2003. Strawberry Cultivar Trial 2002.

Neeser, C. and T. Pheh. 2003. Fruit & Vegetable Program 2002 annual report

Wang, H., S.F. Hwang, K.F. Chang, G.D. Turnbull, and R.J. Howard. 2003. Disease survey of forage alfalfa in Alberta in 2002. Can. Plant Dis. Surv. 83: 87-89.

***In* 2003 Pest Management Research Report - Insects and Plant Diseases.** Expert Committee on Integrated Pest Management, Agriculture and Agri-Food Canada. Ontario. January, 2004.

Chang, K.F., R. Bowness, S.F. Hwang, G.D. Turnbull, D.A. Burke and R.J. Howard. 2003. Evaluation of fungicidal seed treatments for the control of rhizoctonia seedling blight of dry bean in Alberta in 2003.

Chang, K.F., R. Bowness, S.F. Hwang, G.D. Turnbull, D.A. Burke and R.J. Howard. 2003. Evaluation of fungicidal seed treatments for the control of rhizoctonia seedling blight of chickpea in Alberta in 2003.

Chang, K.F., R. Bowness, S.F. Hwang, G.D. Turnbull, D.A. Burke and R.J. Howard. 2003. Evaluation of fungicidal seed treatments for the control of botrytis seedling blight of chickpea in Alberta in 2003.

Chang, K.F., R. Bowness, S.F. Hwang, G.D. Turnbull, D.A. Burke and R.J. Howard. 2003. Evaluation of fungicidal seed treatments for the control of botrytis seedling blight on infested chickpea seed in Alberta in 2003.

Chang, K.F., R.J. Howard, S.F. Hwang and G.D. Turnbull. 2003. Evaluation of fungicidal seed treatments for the control of rhizoctonia seedling blight of soybean in Alberta in 2003.

Chang, K.F., S.F. Hwang, G.D. Turnbull, D.A. Burke and R.J. Howard. 2003. Evaluation of fungicidal seed treatments to control ascochyta seedling blight of chickpea in Alberta in 2003.

Howard, R.J., D.A. Burke, S.L. Pugh, R. Esau, K. Basu, T.J. Labun, and E. Greenough. 2003. Tolerance of turnip rapeseed seedlings to Helix liquid seed treatments.

Howard, R.J., D.A. Burke, S.L. Pugh and T.J. Labun. 2003. Apron Maxx RTA seed treatment research permit trial on dry bean for the control of seed decay and damping-off. 2003.

Howard, R.J., D.A. Burke, S.L. Pugh and T.J. Labun. 2003. Apron Maxx RTA seed treatment research permit trial on chickpea for the control of seed decay and damping-off. 2003.

Howard, R.J., K.F. Chang, D.A. Burke, S.L. Pugh and W.R. McGregor. 2003. Efficacy of foliar fungicides against ascochyta blight on chickpea, 2003.

Hwang, S.F., G.D. Turnbull, K.F. Chang, R. Bowness and R.J. Howard. 2003. Evaluation of fungicidal seed treatments for the control of seedling blight of bird's food trefoil caused by *Rhizoctonia solani* and *Fusarium avenaceum* in Alberta in 2003.

Hwang, S.F., G.D. Turnbull, K.F. Chang, D.A. Burke and R.J. Howard. 2003. Evaluation of fungicidal seed treatments for the control of seedling blight of lentil caused by *Botrytis cinerea* in Alberta in 2003.

Hwang, S.F. , G.D. Turnbull, K.F. Chang and R.J. Howard. 2003. Evaluation of fungicidal seed treatments for the control of seedling blight of canola caused by *Rhizoctonia solani* in Alberta in 2003.

Hwang, S.F., G.D. Turnbull, K.F. Chang and R.J. Howard. 2003. Efficacy of fungicidal seed treatments for the control of rhizoctonia seedling blight of canola in Alberta in 2003.

Hwang, S.F., G.D. Turnbull, K.F. Chang and R.J. Howard. 2003. Evaluation of fungicidal seed treatments for the control of fusarium seedling blight of canola in Alberta in 2003.

Hwang, S.F., G.D. Turnbull, K.F. Chang and R.J. Howard. 2003. Evaluation of fungicidal seed treatments for the control of seedling blight of alfalfa caused by *Rhizoctonia solani* and *Fusarium avenaceum* in Alberta in 2003.

Hwang, S.F., G.D. Turnbull, K.F. Chang and R.J. Howard. 2003. Evaluation of fungicidal seed treatments for the control of seedling blight of clover caused by *Rhizoctonia solani* and *Fusarium avenaceum* in Alberta in 2003.

Hwang, S.F., G.D. Turnbull, K.F. Chang and R.J. Howard. 2003. Evaluation of fungicidal seed treatments for the control of seedling blight of lentil caused by *Rhizoctonia solani* and *Botrytis cinerea* in Alberta in 2003.

Hwang, S.F., G.D. Turnbull, K.F. Chang and R.J. Howard. 2003. Evaluation of fungicidal seed treatments for the control of seedling blight of lentil caused by *Fusarium avenaceum* in Alberta in 2003.

Hwang, S.F., G.D. Turnbull, K.F. Chang and R.J. Howard. 2003. Evaluation of fungicidal seed treatments for the control of seedling blight of field pea caused by *Fusarium avenaceum* in Alberta in 2003.

Hwang, S.F., G.D. Turnbull, K.F. Chang and R.J. Howard. 2003. Evaluation of fungicidal seed treatments for the control of rhizoctonia seedling blight of field pea in Alberta in 2003.

Wang H., S.F. Hwang, G.D. Turnbull, K.F. Chang and R.J. Howard. 2003. Evaluation of seed piece treatments for the control of fusarium seed piece decay of potato in Alberta in 2003.

Wang H., S.F. Hwang, G.D. Turnbull, K.F. Chang and R.J. Howard. 2003. Greenhouse evaluation of foliar fungicides for the control of anthracnose in bean in 2003.

Wang H., S.F. Hwang, G.D. Turnbull, K.F. Chang and R.J. Howard. 2003. Greenhouse evaluation of fungicidal seed treatments for the control of seed-borne botrytis in lentil in 2003.

Wang H., S.F. Hwang, G.D. Turnbull, K.F. Chang and R.J. Howard. 2003. Greenhouse evaluation of fungicidal seed treatments for the control of seed-borne ascochyta in lentil in 2003.

Wang H., S.F. Hwang, G.D. Turnbull, K.F. Chang and R.J. Howard. 2003. Greenhouse evaluation of fungicidal seed treatments for the control of seed-borne ascochyta in chickpea in 2003.

Wang H., S.F. Hwang, G.D. Turnbull, K.F. Chang and R.J. Howard. 2003. Greenhouse evaluation of fungicidal seed treatments for the control of seed-borne anthracnose in bean in 2003.

Wang H., S.F. Hwang, G.D. Turnbull, K.F. Chang and R.J. Howard. 2003. Greenhouse evaluation of fungicidal seed treatments for the control of seed-borne anthracnose in lentil in 2003.

Wang H., S.F. Hwang, G.D. Turnbull, K.F. Chang and R.J. Howard. 2003. Greenhouse evaluation of fungicidal seed treatments for the control of seed-borne botrytis in chickpea in 2003.

Wang H., S.F. Hwang, G.D. Turnbull, K.F. Chang and R.J. Howard. 2003. *In vitro* evaluation of the inhibitory effect of eight fungicides on mycelial growth on *Colletotrichum lindemuthianum* causing anthracnose in dry bean in 2003.

Wang H., S.F. Hwang, G.D. Turnbull, K.F. Chang and R.J. Howard. 2003. *In vitro* evaluation of the inhibitory effect of six fungicides on mycelial growth on *Colletotrichum truncatum* causing anthracnose in lentil in 2003.

Wang H., S.F. Hwang, G.D. Turnbull, K.F. Chang and R.J. Howard. 2003. *In vitro* evaluation of the inhibitory effect of ten fungicides on mycelial growth of *Ascochyta rabiei* causing ascochyta blight in chickpea in 2003.

Wang H., S.F. Hwang, G.D. Turnbull, K.F. Chang and R.J. Howard. 2003. *In vitro* evaluation of the inhibitory effect of six fungicides on mycelial growth of *Ascochyta lentis* causing ascochyta blight in lentil in 2003.

Wang H., S.F. Hwang, G.D. Turnbull, K.F. Chang and R.J. Howard. 2003. *In vitro* evaluation of the inhibitory effect of seven fungicides on mycelial growth of *Botrytis cinerea* causing grey mold in chickpea in 2003.

Wang H., S.F. Hwang, G.D. Turnbull, K.F. Chang and R.J. Howard. 2003. *In vitro* evaluation of the inhibitory effect of five fungicides on mycelial growth of *Fusarium*.

Wang H., S.F. Hwang, G.D. Turnbull, K.F. Chang and R.J. Howard. 2003. *In vitro* evaluation of the inhibitory effect of five fungicides on mycelial growth of *Rhizoctonia*.

Abstracts and Papers in Refereed Journals

Bandara, M., Webber J. and A. Fox. 2003. Fall-seeded desi chickpea in southern Alberta. Proceedings of the PulseDays. 2004 p. 73.

Bandara , M., C. Weisbach, J. Webber and T. Warkentin. 2003. Chickpea crop improvement and agronomic work in Alberta. Proceedings of the International Chickpea Conference. Raipur, India. p.12-13.

Baron, V.S., H.G. Najda, D.H. McCartney, M. Bjorge and G.W. Lastiwka. 2003. Winter weathering effects on corn grown for grazing in a short-season area. Can. J. Plant Sci. 83: 333-341.

Calpas, J.T., M.N. Konschuh, C.C. Toews, and J.P. Tewari. 1999. Virulence and molecular diversity in isolates of *Botrytis cinerea* recovered from greenhouse tomato in Alberta. Can. J. Plant Pathol. 23: 184 [abstract].

Chang, K.F., Hwang, S.F., Burke, D.A., Howard, R.J., Blade, S.F., and Bandara, M. 2003. Responses of *Mentha* spp. to soilborne pathogens and chemical control of stolon rot on peppermint. Proceedings of the 8th ICPP, vol. 2, p.64.

Fox, A. S. and L. M. Dosdall. 2003. Reproductive biology of *Ceutorhynchus obstrictus* (Coleoptera: Curculionidae) on wild and cultivated Brassicaceae in southern Alberta. Journal of Entomological Science 38: 533-544.

Hwang, S.F., Gossen, B.D., Chang, K.F., Turnbull, G.D., Howard, R.J., and Blade, S.F. 2003. Etiology, impact and control of rhizoctonia seedling blight and root rot of chickpea on the Canadian prairies. Can. J. Plant Sci. 83: 959-967.

Hwang, S.F., Gossen, B.D., Turnbull, G.D., Chang, K.F., Howard, R.J., and Blade, S.F. 2003. Soil and seed conditions affect rhizoctonia seedling blight and seed yield of field pea. Proceedings of the 8th ICPP, vol. 2, p. 327.

McKenzie, R.H., Middleton, A.B., DeMulder, J. and Bremer, E. 2003. Fertilizer response of barley silage in southern and central Alberta. Can. J. Soil Sci. (Submitted)

McKenzie, R.H., E. Bremer, L. Kryzanowski, A. B. Middleton, E. D. Solberg, D. Heaney, G. Coy, and J. Harapiak. 2003. Yield benefit of phosphorus fertilizer for wheat, barley and canola in Alberta. Can. J. Soil Sci. 83:431-441.

McKenzie, R.H. and E. Bremer. 2003. Relationship of soil phosphorus fractions to phosphorus soil tests and fertilizer response. Can. J. Soil Sci. 83: 443-449.

Middleton, A.B., Bremer, E. and McKenzie, R.H. 2003. Winter wheat response to nitrogen fertilizer form and placement in southern Alberta. Can. J. Soil Sci. (Submitted)

Smith E.G., R.H. McKenzie and C.A. Grant. 2003. Optimal input use when inputs affect price and yield. Can. J. Agric. Econ. 51:1-13.

Wang, H., S.F. Hwang, K.F. Chang, G.D. Turnbull and R.J. Howard. 2003. Suppression of important pea diseases by bacterial antagonists. Biocontrol 48: 447-460.

Yang, R., T. Z. Ye, S.F. Blade and M. Bandara. 2004. Efficiency of spatial analysis of field pea variety trials. Crop Science. 44(1): 49-55.

Extension Publications

Bandara, M. 2003. Cultivation and assessment of field pepperweed (*Lepidium campestre* L.) for glucoraphanin, a pharmaceutical and functional food ingredient. http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/opp7185?opendocument

Konschuh, M.N. and R.C.J. Spencer. 2003. Potato Scab - Frequently Asked Questions. AAFRD Ag-Info Centre FAQ, June 4, 2003. <http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/faq6699?opendocument>. June

McKenzie, R.H., J.F. Dormarr, B. Adams and W. Willms. 2003. Manure application and nutrient balance on rangeland. Agdex 538-1. < http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/agdex6609?opendocument>

McKenzie, R.H. 2003. Soil pH and plant nutrients. Agdex 531-4 <http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/agdex6607?opendocument>

Murray, C.L. 2003. Alberta Perennial Trial Garden Report 1999-2001. <http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/opp7204?opendocument>

Murray, C.L. and N.G. Seymour. 2003 2003 Updated on Evaluating Woody Plants for Hardiness and Landscape quality in AB. http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/opp4045?opendocument>.

Walburger, A and R.H. McKenzie. 2003. Sustainable crop rotations for Alberta Brown Soil Zone

Woods, S.A. and **L.E. Hingley.** 2003. CDCS Annual Report 2002 - Soil and Water Agronomy Program. Alberta Agriculture's Ropin' the Web site. <http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/opp6888?OpenDocument>. June.

Woods, S.A. 2003. Three-Year Phosphorous Release Rates From Composted Manure. <http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/opp7141?opendocument>. July

Woods, S.A. 2003. Long Term Viability And Salinity Tolerance Of Dryland Forage And Turf Grasses <http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/opp7141?opendocument>. Feb. Updated July.

Popular Articles

Barkley, S.J. 2003. Pesticide licencing and continuing education credits. Communication Connection #6. March 21.

Barkley, S.J. 2003. Greenhouse crops program hosting open house at CDCS. Communication Connection #6. April 25.

Barkley, S.J. 2003. Brown evergreens. Agri-News. April 28.

Barkley, S.J. 2003. Brown evergreens. Brooks Bulletin. April 30.

Barkley, S.J. 2003. Evergreen browning. Agri-News. May 12.

Barkley, S.J. 2003. Evergreen browning. Brooks Bulletin. May 12.

Barkley, S.J. 2003. Maintaining healthy Trees. Agri-news. May 12.

Barkley, S.J. 2003. Composting. Town and Country Chronicle. May 12.

Barkley, S.J. 2003. Spruce needles disappearing. Agri-News. June 2.

Barkley, S.J. 2003. Chickpeas bring researchers together. Agri-News. June 2.

Barkley, S.J. 2003. Fall yard care. Agri-News. Sept 22.

Barkley, S.J. 2003. Autumn needle shed. Agri-News. Sept 22.

Barkley, S.J. 2003. Some bulbs you dig up—some you plant. Agri-News. Sept 29.

Barkley, S.J. 2003. Care for your garden tools. Agri-News. Oct 27.

Chang, K.F. and R.J. Howard. 2003. Black Currant Diseases. Agri-News. Jan 13.

Cote, P. 2003. Greenhouse open house. Agri-News. April 28.

Delanoy, L. 2003. Irrigation/Soils Fertility Workshop. Communication Connection. Jan 31.

Delanoy, L. 2003. Bow Island field day. Communication Connection. July 11.

Dunn, R. 2003. Fusarium—it's here, its bad. Irrigating Alberta. Spring.

Howard. R.J. and M. Mirza. 2003. Geranium bacterial blight. Greenhouse Business. March.

Howard. R.J. 2003. Tomato pepino mosaic virus. Breaking News. April 10.

Howard, R.J. 2003. Tomato pepino mosaic virus. Agri-News. April 16.

Howard, R.J., N. Savidov, M. Mirza, and J.T. Calpas. 2003. Pepino Mosaic Virus alert for greenhouse growers. Agri-News, April 21, p. 2.

Howard, R.J. 2003. Provincial black knot survey. Agri-News. May 5.

Howard, R.J. P.S. Bains, and M. Mirza. 2003. What to do if you find a fungus growing inside the pepper fruit. Greenhouse Business. May/July.

Konschuh, M.N. 2003. What is the best potato variety? Agri-News. December 8, p. 2.

McKenzie, R.H. 2003. Spring fertilizer recommendations. Agri-News. March 31.

McKenzie, R.H. 2003. What's the difference? Agri-News. April 7.

McKenzie, R.H. 2003. Soil pH and plant nutrients: what's the connection? Agri-News. May 5.

McKenzie, R.H. 2003. 2003 Canola productivity and lygus bugs. June 30

McKenzie, R.H. 2003. Plots show effects of seeding rate, date and openers. Germinator June 2003, Volume 2 – 03.

McKenzie, R.H. 2003. Fertilizing malt barley for yield and quality. In Barley Country Spring 2003, Volume 12 No. 1.

McKenzie, R.H., E. Bremer, L. Kryzanowski, A.B. Middleton, E.D. Solberg, D. Heaney, G. Coy and J. Harapiuk. 2003. Yield Benefit of Phosphorus Fertilizer for Wheat, Barley and Canola in Alberta. In Better Crops.

Murray, C. L. 2003. Lake Country Ohio Nurseries Welcome the Western Nursery Growers Group. Prairie Landscape Magazine. Dec. 2004.

Murray, C. L. and N.G Seymour. 2003. The evaluation of six systems of holding harvested trees during the shipping season. Prairie Landscape Magazine. Oct/Nov 2003.

Najda, H. 2003. Studies on tall fescue seed production under irrigation. Forage Seed News. Winter. 10 (1): 35-37.

Najda, H. 2003. Southern Alberta update on grass seed production. Forage Seed News. Winter. 10 (3): 15.

Najda, H. 2003. Southern Alberta update on grass seed production. Forage Seed News. Spring/Summer. 10(2): 12.

Neeser, C., and T. Pheh. 2003. Fruit and Vegetable Production: A Research Update. Alberta Market Gardeners Association News, Spring 2003

Neeser, C. 2003. The Science of Vegetable Storage. Alberta Market Gardeners Association News. Fall 2003

Neeser, C. 2003. Soil pH, Cation exchange capacity, and soil organic matter: what do the numbers mean? Alberta Market Gardeners Association News, Summer 2003.

Pheh, T. 2003. Budding your own Trees. The Prairie Fruit Journal Vol. 10, issue 1-2.

Savidov, N. 2003. Aquaponics, an environmentally friendly. Agri-News. Jan.

Savidov, N. 2003. Greenhouse industry profile. Greenhouse Business. March.

Savidov, N. and M. Mirza. 2003. Crop reports. Greenhouse Business. March.

Savidov, N. 2003. Progress of greenhouse research in Alberta. November. <http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/opp7690?opendocument>

Savidov, N. and M. Mirza. 2003. Early crop management guidelines. Greenhouse Business. December. <http://www1.agric.gov.ab.ca/$department/newslett.nsf/all/ghb4434?OpenDocument>.

Woods, S.A. Dirt-whats not to like. Agrinews. Feb 24.

Woods, S.A. Dirt-whats not to like. Brooks Bulletin. March 12.

Woods, S.A. 2003. Yield maps show salinity impacts on dry beans. Pulse Crop News – Summer 2003, Alberta Pulse Growers. June 2003.

Woods, S.A. 2003 Ag research reports on-line. Agri-News. September 8, 2003.

Woods, S.A. 2003 Ag research reports on-line. Brooks Bulletin. September 17, 2003.

Posters

Calpas, J. T., M. Konschuh and S. Lisowski. 2002. Preliminary investigation into developing DNA fingerprints for geographically distinct populations of the mountain pine beetle, *Dendroctonus ponderosa*. (Coleoptera: Scolytidae). Entomological Society of Alberta, 50th Annual Meeting, Oct. 24-26, 2002, Lethbridge, Alberta.

Chang, K.F., S.F. Hwang, D.A. Burke, R.J. Howard, S.F.Blade, and M. Bandara. 2003. Responses of *Mentha* spp. to soilborne pathogens and chemical control of stolon rot on peppermint. 8th International Congress of Plant Pathology, Feb. 2-8, 2003, Christchurch, New Zealand.

Cole, D. E., N.L. Olstad, C. Yoder, H. Najda, J.R. Moyer, J.R. King, J. Beaudoin, M. Watts, M. Tremblay. 2003. Tolerance of forage and turf seed crops to herbicides. Canadian Alfalfa and Grass Seed Conference. Banff, AB. January.

Howard, R.J., S.L.I. Lisowski, D.A. Burke, and D.L. Slomp. 2003. Plant pathology program. Alberta Horticultural Congress and Trade Show, Edmonton, AB, Nov. 13-14.

Howard, R.J. 2003. Potato diseases – the year in review. Potato Growers of Alberta Annual Meeting, Banff, AB, Nov. 12-14.

Hwang, S.F., K.F. Chang, B.D Gossen, G.D. Turnbull, and R.J. Howard. 2003. Effects of seeding conditions and seed quality on rhizoctonia seedling blight and seed yield of lentil. The 74th Annual Meeting of CPS, June 22-25, Montreal, Quebec.

Hwang, S.F., B.D. Gossen, G.D. Turnbull, K.F. Chang, R.J. Howard, and S.F. Blade. 2003. Soil and seed conditions affect rhizoctonia seedling blight and seed yield of field pea. 8th International Congress of Plant Pathology, Feb. 2-8, 2003, Christchurch, New Zealand.

Konschuh, M.N. and S. Dalpé. 2003. Effect of Royal MH60 for size control in Russet Burbank potatoes – 1st year. Annual Meeting of the Potato Growers of Alberta, Banff, AB, November 12-14.

Konschuh, M.N. and S. Dalpé. 2003. Effect of Royal MH60 for size control in Norvalley potatoes – 1st year. Annual Meeting of the Potato Growers of Alberta, Banff, AB, November 12-14.

Konschuh, M.N. and S. Dalpé. 2003. Timing of power hilling for Russet Burbank in southern Alberta – 1st year. Annual Meeting of the Potato Growers of Alberta, Banff, AB, November 12-14.

Murray, C.L. and N.G. Seymour. 2003 The evaluation of six systems of holding harvested trees during the shipping. Alberta Horticultural Congress. November.

Najda, H.G. and A. Kruger. 2003. Effect of time and method of establishment on seed yield of irrigated perennial ryegrass. 5th International Herbage Seed Conference, University of Queensland – Gatton Campus, Australia. November 23-26.

Wang, H., S.F. Hwang, K.F. Chang, G.D. Turnbull, and R.J. Howard. 2003. Fungicide treatments for controlling fusarium seed piece decay of potato in Alberta. The 74th Annual Meeting of CPS, June 22-25, Montreal, Quebec.

Woods, S.A., Kachanoski, R.G. and Dyck, M.F. 2003. Long-term solute transport under semi-arid conditions: Pedon to landscape scale. *Presented at* the 2003 EGS-AGU-EUG (European Geophysical Society, American Geophysical Union, European Union of Geoscience) Joint Assembly. Nice, France. April 2003.

Proceedings

McKenzie, R.H., A. B. Middleton and R. Dunn. 2003. Management to optimize mustard production. Prepared for the Western Canada Agronomy Workshop.

Bremer, E and R.H. McKenzie. 2003. Silage Production – Building blocks for high yield and quality. Prepared for the Western Canada Agronomy Workshop

Najda, H.G. and A. Kruger. 2003. Effect of time and method of establishment on seed yield of irrigated perennial ryegrass. *In* Proceedings 5th International Herbage Seed Conference, University of Queensland – Gatton Campus, Australia. November 23-26. pp. 123-127.

Book

Chang, K.F., D.A. Kaminski, and R.J. Howard. 2003. Diseases of Other Crops. Pp.259-277 *In*: Bailey, K.L., Gossen, B.D., Gugel, R.K., and Morrall, R.A.A. (eds.), Diseases of Field Crops in Canada. (3rd edition). The Canadian Phytopathological Society, Saskatoon, Saskatchewan, Canada. 290 pp

Presentations at Professional Meetings, Conferences and Seminars

Bremer, E and R.H. McKenzie. 2003. Silage Production – Building blocks for high yield and quality. Western Canada Agronomy Workshop July 21-23, 2003 Saskatoon, Saskatchewan. Pages 46-49.

Howard, R.J. 2003. An update on soil-borne diseases of potato. Western Potato Council Annual Meeting, Lethbridge, AB, Jan. 14-16.

Howard, R.J. 2003. Tree diseases on the Canadian prairies. International Society of Arboriculture, Prairie Chapter, 2003 Conference, Trade Show and Annual Meeting, Medicine Hat, AB, Sept. 17-20.

Howard, R.J., D.A. Burke, D.L. Slomp, C.A. Davidson, W.G.D. Fernando, and J. Zhang. 2003. Occurrence of black knot on *Prunus* spp. in Alberta in 2003. Annual Meeting of the Plant Pathology Society of Alberta and the Saskatchewan Regional Group of the Canadian Phytopathological Society, Lloydminster, AB, Oct. 20-22.

McKenzie, R.H., A. B. Middleton and R. Dunn. 2003. Management to optimize mustard production. Western Canada Agronomy Workshop July 21-23, 2003 Saskatoon, Saskatchewan. Pages 40-45.

Najda, H.G. 2003. Studies on tall fescue seed production under irrigation. Canadian Alfalfa and Forage Seed Conference. Banff, AB. Jan.

Neeser, C. 2003. Integrated Management of Black Currants: A Research Update. Alberta Horticultural Congress, Edmonton, Nov. 12, 2003.

Woods, S.A. and L. Hingley. 2003. Introduction of the soil and water agronomy program and EM38 demonstration for the AAFRD Executive Committee Tour. June 18, 2003.

Woods, S.A. and L. Hingley. 2003. Introduction of the soil and water agronomy program and EM38 demonstration for Minister McLelland's Tour of CDCS. August 7, 2003.

Woods, S.A. and L. Hingley. 2003. Introduction of the soil and water agronomy program, lecture on the salinity tolerance of crops and EM38 demonstration for Olds College students. August 27, 2003.

Woods, S.A. and L. Hingley. 2003. EM38 mapping demonstration for University of Lethbridge Geography 4760 (Agricultural Soil Management) students. September 12, 2003.

Woods, S.A. 2003. Soil salinity and crop salinity tolerances lecture and field demonstration for University of Lethbridge Geography 4760 (Agricultural Soil Management) students. September 26, 2003.

Presentations at Industry Meetings

Baines, P.S. and R.J. Howard. 2003. For Pythium to powdery mildes–The importance of diseases in greenhouse corps. Alberta Horticultural Congress and Trade Show, Edmonton, AB Nov 13-14.

Bandara M. and R.Gaudiel. 2003. Up-date on Echinacea research at Crop Diversification Centre South. Presented at the Echinacea workshop at CDCN on March 12, 2003.

Bandara M. 2003. Regional Pulse Variety Evaluations in Southern Alberta. Presented at Pulse Growers' Annual General Meeting- Zone 1. Taber ,AB December 11, 2003.

Howard, R.J. 2003. Bacterial ring rot of potatoes. Bacterial Ring Rot Inspectors' Workshop, Brooks, AB, July 24.

Howard, R.J. 2003. Crop disease overview for southern Alberta in 2002. Agronomy Update Conference, Lethbridge, AB, Jan. 13-14.

Howard, R.J. 2003. Designing a disease management program that meets the needs of your operation. Workshop on Managing Diseases in Greenhouse Vegetables. Medicine Hat, AB, Dec. 3 and Gull Lake, AB, Dec. 10.

Howard, R.J. 2003. Dry bean disease update. Agricore United Bean Grower Meetings, Burdett, AB, Feb.27 and Taber, AB, Feb. 28.

Howard, R.J. 2003. Managing greenhouse crop diseases. Alberta Horticultural Congress and Trade Show, Edmonton, AB, Nov. 13-14.

Howard, R.J. 2003. Potato diseases – the year in review. Potato Growers of Alberta Annual Meeting, Banff, AB, Nov. 12-14.

Howard, R.J. 2003. Update on 2003 research studies into the management of root and stem rot diseases in greenhouse cucumbers. Workshop on Managing Diseases in Greenhouse Vegetables. Medicine Hat, AB, Dec. 3 and Gull Lake, AB, Dec. 10.

McKenzie, R.H. 2003. Crop Walk tours with Ducks Unlimited, RT Linkages and SARA. Magrath, AB, May 1.

McKenzie, R.H. 2003. Crop Walk tours with Ducks Unlimited, RT Linkages and SARA. Lethbridge, AB, June 5.

McKenzie, R.H. 2003. Crop Walk tours with Ducks Unlimited, RT Linkages and SARA. Bow Island, AB. June 12

McKenzie, R.H. 2003. Crop Walk tours with Ducks Unlimited, RT Linkages and SARA. Lethbridge, AB. June 23.

McKenzie, R.H. 2003. Crop Walk tours with Ducks Unlimited, RT Linkages and SARA. Magrath, AB. June 23.

McKenzie, R.H. 2003. CACDI Farm Tour. July 17

McKenzie, R.H. 2003. Winter Wheat conference and tour –Lethbridge, AB. July 24

McKenzie, R.H. 2003. Winter Tour Magrath, AB July 25

McKenzie, R.H. 2003. Bow Island Substation Field Day AM. Bow Island, AB. July 29.

McKenzie, R.H. 2003. Bow Island Dryland Plot Field Day PM. Bow Island, AB. July 29.

McKenzie, R.H. 2003. Ag Tech Center Field Day. Lethbridge, AB. July 31.

Murray, C.L. 2003. Nursery crops at CDCS. Western Nursery Growers Group Annual Meeting. Edmonton, AB. Nov. 2003.

Najda, H.G. 2003. Studies on tall fescue seed production under irrigation. Canadian Alfalfa Seed Conference. Banff, AB, January 12-14.

Najda, H.G. 2003. Studies on tall fescue seed production under irrigation. Bow Island Substation Update. Bow Island, AB, March 11.

Neeser, C. and L. Delanoy. 2003. Integrated Pest Management in Carrots. Fruit and Vegetable Highlights Seminar. Lethbridge, AB, Feb. 18 , Stettler, AB, Feb. 19 , and Edmonton, AB, Feb. 20.

Neeser, C. and T. Pheh. 2003. Research Update from Fruit and Vegetable Program at the Crop Diversification Centre South, Fruit and Vegetable Highlights Seminar. Lethbridge, AB, Feb. 18 , Stettler, AB, Feb. 19 , and Edmonton, AB, Feb. 20.

Neeser, C. 2003. Integrated Management of Black Currants: Results from the First Year. Prairie Natural Processing Inc. Annual Meeting, Red Deer, Feb. 18, 2003.

Neeser, C. 2003. Black Currant Research Update. Black Currant Network Meeting, Brooks, March 12, 2003.

Neeser, C. 2003. Integrated Pest Management in Carrots. UFA Vegetable Grower Meeting, Lethbridge, AB, April 10, 2003.

Neeser, C. 2003. The New Fruit & Vegetable Program at CDC-South. UFA Vegetable Grower Meeting, Lethbridge, AB, April 10, 2003.

Neeser, C. 2003. Black Currant Integrated Crop Management Research Update. Prairie Natural Processing Field Day, Red Deer, July 29, 2003.

Neeser, C. 2003. Functional Foods & Nutraceuticals: New Opportunities for Berry Crops. Field Day of the Fruit Growers Society of Alberta, Elnora, August 13, 2003.

Pheh, T. 2003. Fruits for Wine-Making, A "Horticultural Week" Workshop. Olds College, Olds, AB, July 8, 2003.

Pheh, T. 2003. Veritable Gardeners, A "Horticultural Week" Workshop, Olds College, Olds, AB, July 8, 2003.

Pheh, T. 2003. Apple Production in Alberta. Two Hills Horticultural Society, Two Hills, AB. Aug. 9, 2003.

Pheh, T. 2003. Pruning Fruit Trees, Olds College, Olds, AB, Nov. 22, 2003.

Savidov, N.A. 2003. Getting ready for the new crop. Workshop on managing diseases in greenhouse vegetables. Medicine Hat, AB. Dec 3.

Savidov, N.A. 2003. Getting ready for the new crop. Workshop on managing diseases in greenhouse vegetables. Gull Lake, AB. Dec 10.

Weisbach C., M. Bandara, T. Warkentin and B. Vandenberg. 2003. Chickpea and lentil cultivar improvement program in southern Alberta. Presented at Pulse Growers' Annual General Meeting- Zone 1. Taber, AB December 11, 2003.

Woods, S.A. and L. Hingley. 2003. Soil Salinity and Elevation Mapping of CACDI Potato Crop. CACDI Tour, Lethbridge, AB, July 16.

Woods, S.A. and L. Hingley. 2003. Soil Salinity Tolerance of Potatoes. Potato Growers of Alberta, Annual Field Day, Lethbridge, AB, July 17.

Media Interviews

Bandara, M. 2003. Chickpeas rated good cash crop for southern Alberta. Brooks Bulletin, June 25.

Bandara, M. 2003. Southeastern crop diversification centre hosts well attended field day. Brooks and County Chronicle. August 18.

Dunn. R. 2003. Army cutworm outbreak possible in southern Alta. Western Producer. May 15.

Howard. R.J. 2003. Plant detective searchs for new disease cures. Western Producer. May 1.

Howard, R.J. 2003. Provincial black knot survey. Call of the Land. May 5.

Howard, R.J. 2003. Seeking ways to control stem and root rot in greenhouses. Brooks Bulletin. August 19.

Konschuh, M.N. 2003. A well-stocked toolbox. Top Crop Manager, April 2003.

Konschuh, M.N. 2003. Alberta potatoes: More than meets the eye. Reach and Discover, Fall 2003.

McKenzie, R.H. 2003. For researchers, seeding is all a big plot. Lethbridge Herald. April 19.

McKenzie, R.H. 2003. Sulfur variability makes dealing with deficiencies difficult. Western Producer. May 1.

McKenzie, R.H. 2003. New agronomic recipe boosts mustard yields. Western Producer. May 1.

McKenzie, R.H. 2003. Fertilizer impacts studied in western barley trials. Lethbridge Herald. May 17.

McKenzie, R.H. 2003. Study aims to help farmers optimize their barley yields. Lethbridge Herald. June 6.

McKenzie, R.H. 2003. Producers get close-up look at crop research. Lethbridge Herald. June 6

McKenzie, R.H. 2003. Winter cereal production. 2/7 Global TV. May 1

McKenzie, R.H. 2003. soil nutrient and moisture management. 2/7 Global TV. May 1

McKenzie, R.H. 2003. Interview on malting barley research; triticale research. 2/7 Global TV. June 11 June 15, 16, and other times.

McKenzie, R.H. 2003. Fall Seeded Crops. Call of the Land. September 15.

McKenzie, R.H. 2003. Timothy Production. Lethbridge Herald. August 16.

McKenzie, R.H. 2003. Soil moisture and fall irrigation. Lethbridge Herald. August 18.

McKenzie, R.H. 2003. Malt Barley. Lethbridge Herald. August 21

McKenzie, R.H. 2003. Clubroot in canola. Lethbridge Herald. Sept 6.

McKenzie, R.H. 2003. Soil moisture situation and fall irrigation management. Global 2/7. Aug 18.

McKenzie, R.H. 2003. current cropping conditions in southern Alberta. A Channel. Aug 21.

McKenzie, R.H. 2003. Clubroot in canola. Global 2/7. Sept 11 and 10.

McKenzie, R.H. 2003. Winter Wheat production this fall. Call of the Land. Sept 11.

McKenzie, R.H. 2003. New Holland: Faster better, more even germination. Fall.

McKenzie, R.H. 2003. Optimizing mustard production. Top Crop Manager. Fall.

McKenzie, R.H. 2003. Irrigation Alberta: Interview on soil testing on irrigated land. Irrigation Alberta. Fall 2003, Vol 7. No. 2. pp 26-27

McKenzie, R.H. 2003. Using additives in nitrogen fertilizer management. Call of the Land. Nov. 13.

Murray, C.M. 2003. CDC works to up tree transplanting success rate. Brooks Bulletin. August 5.

Murray, C.M. 2003. New study looks at holding systems for caliper trees. Call of the Land. August 11.

Neeser, C. 2003. Room for growth in Alta. vegetables. Western Producer. May 8.

Safronovich, C. 2003. CDC grow the tree seeds for better Alberta forests. Brooks Bulletin. September 16.

Savidov. N. 2003. Next step in improving aquaculture system. Brooks Bulletin. March 12.

Savidov. N. and C. Neeser. 2003. Local researchers work to put better nutrients in vegetables. Brooks and County Chronicle. August 25.

Savidov. N. and C. Neeser. 2003. Vegetables for better nutrition. Brooks Bulletin. September 2.

Woods, S.A. 2003. Salty soil, spuds a bad mix. Rick Swihart, The Lethbridge Herald, Lethbridge, AB. July 17, 2003.

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Glossary

AAFC	Agriculture and Agri-Food Canada
AAFRD	Alberta Agriculture, Food and Rural Development
AARI	Alberta Agriculture Research Institute
AFFPA	Alberta Farm Fresh Producers Association
ARC	Alberta Research Council, Vegreville, AB
CDCN	Crop Diversification Centre North, Edmonton, AB
CDCS	Crop Diversification Centre South, Brooks, AB
GPS	Global Positioning System
MII	Matching Investment Initiative
U of A	University of Alberta
U of S	University of Saskatchewan